Our team recently invented a novel pretreatment called Co-solvent Enhanced Lignocellulosic Fractionation (CELF) that applies renewable tetrahydrofuran (THF) in a homogeneous solution with dilute sulfuric acid and water to fractionate cellulosic biomass and achieve high yields of sugars or furfural, 5-hydroxymethylfurfural, and levulinic acid for biological or catalytic conversion, respectively, into fuels and chemicals. Recovering highly volatile THF for recycle from post CELF liquid precipitates nearly pure lignin. Operating CELF at relatively severe conditions can convert about 87% of pentose sugars to furfural for catalytic conversion, and glucan-rich solids were further reacted with dilute acid to levulinic acid at about 75% of theoretical or digested to glucose with high yields at very low enzyme loadings. For biological conversion, CELF recovered about 85-90% of available sugars from hemicellulose while removing similar fractions of lignin. Of note, hydrolysis of CELF solids with just 2 mg enzyme/g glucan achieved nearly theoretical glucan yields, albeit at longer times, and simultaneous saccharification and fermentation (SSF) hydrolyzed and fermented about 90% of CELF glucan at an enzyme loading of only 5 mg-enzyme g-glucan\(^{-1}\). CELF also allowed higher ethanol titers in SSF than possible with dilute acid pretreated solids while maintaining high yields. Consolidated bioprocessing (CBP) with \textit{Clostridium thermocellum} that produces its own enzymes and metabolizes the sugars released solubilized most CELF glucan in 1 day without adding enzymes. Additionally, CELF realized similar results with agricultural residues and recalcitrant hardwoods. The remarkable features of CELF can be invaluable for gaining new insights into biomass deconstruction that suggest advanced approaches to overcoming recalcitrance, the key economic obstacle to fuels and chemicals from biomass.