The University of California Riverside recently invented a novel pretreatment called Co-solvent Enhanced Lignocellulosic Fractionation or CELF that applies renewable tetrahydrofuran (THF) as an aqueous co-solvent to greatly increase yields of primary (i.e., sugars) or secondary (i.e., furfural, 5-hydroxymethylfurfural (5-HMF), and levulinic acid) fuel precursors from dilute acid processing of lignocellulosic biomass. For biological conversion to fuels and chemicals, CELF pretreatment of corn stover at 160°C for 25 mins with 0.5% sulfuric acid recovered over 95% of the major hemicellulose sugars (glucose, xylose, arabinose) in the liquid while also solubilizing over 90% of the lignin. CELF was particularly noteworthy in realizing nearly theoretical glucose yields from the resulting glucan-enriched solids at enzyme loadings as low as 2 mg-enzyme/g-glucan due to high hemicellulose and lignin removal. Furthermore, 90% of the same pretreated solids could be converted to ethanol by simultaneous saccharification and fermentation (SSF) in 7 days at an enzyme loading of only 5 mg-enzyme g-glucan \(^{-1}\), while consolidated bioprocessing (CBP) with \textit{Clostridium thermocellum} consumed most of the glucan in only 1 day. The highly volatile THF could be evaporated from the CELF liquid stream to produce a nearly pure lignin feedstock. For catalytic pathways, about 87% of the pentose sugars in biomass could be converted to furfural by operating CELF at more severe conditions of 170°C for 40 to 60 mins with 1 wt% sulfuric acid. The remaining glucan-enriched solids could be enzymatically digested to glucose or further reacted with dilute acid to produce levulinic acid with a yield of about 75% of theoretical from maple wood. Metal halide acid catalysts, such as \text{FeCl}_3, increased yields to about 95% and 51% of theoretical for furfural and 5-HMF, respectively, from maple wood and corn stover in “one-pot.” In fact, CELF demonstrated consistent performance with a number of lignocellulosic feedstocks including agricultural residues and highly recalcitrant hardwoods. Beyond its ability to enhance yields of primary and secondary fuel precursors, CELF can provide a valuable tool for understanding biomass deconstruction.