Radical cyclizations are a mainstay of synthetic organic chemistry. Although these reactions are frequently used in small-scale synthetic applications, they are seldom used on industrial scale. This is due to a reliance on Bu₃SnH, which is has historically been regarded as the best synthetic equivalent to a hydrogen atom. The toxicity and the poor atom-economy of the trialkyltin compounds demands that they be replaced; new hydrogen atom donors are needed. We have shown that transition metal complexes (e.g. CpCr(CO)₃H, HV(CO)₄dppe, and Co(dmgBF₂)₂(THF)₂) can be used as hydrogen atom donors in radical reactions. Some of these hydrogen atom donors are regenerated from H₂, so the reactions using the transition-metal complexes are catalytic, and generate virtually no waste. In this talk, I will explain how we have used M–H bond thermochemistry to predict and control how a system processes a given organic substrate. I report on a new system, [CpV(CO)₃H]⁻, which catalyzes electron transfer from H₂ (representing the interconversion of chemical energy and electrical energy). I have used this system to catalyze the radical cyclization of alkyl iodides.