The demand for utilizing clean and sustainable energy is today more urgent than ever. One of the most promising approaches is to use renewable energies like solar and wind to produce liquid fuels which can be easily stored and transported to where they are needed. Today, the problem of clean energy storage is much more acute than clean energy generation. Hydrogen has gained the most attention as a carbon-free fuel, however its use is not without problems. The most significant is that it is a gas which must be compressed in order to store efficiently, generating a huge loss in the overall energy efficiency of using hydrogen as a fuel. Hydrogen peroxide, H_2O_2, is a carbon-free cousin of H_2 which contains nearly as much energy – but is an aqueous liquid and not a gas. While this has been known for years, the lack of suitable catalysts has held back development of peroxide technologies. Our research aims to change this situation. We research the use of soft organic materials as cheap and large-scale electrodes which catalytically can generate peroxide, as well as turn liquid peroxide back into electrical energy. Unlocking the peroxide energy cycle hinges on the development of appropriate catalysts for efficiently generating peroxide from electricity, and the reverse process of converting peroxide back into electrical energy. We will reach our goal by molecular engineering to tune organic conducting polymers to create large-area catalytic sponges which soak up water and oxygen and produce peroxide. The objective is to create a sustainable and scalable solution to peroxide energy conversion catalysts based on organic semiconducting polymers. We aim to synthesize polymers optimized to be efficient cathodic and photocathodic catalysts for the reduction of oxygen selectively to peroxide. Our approach will hopefully not only vitalize peroxide technologies, but provide also next generation low-cost catalysts which will find their way into other applications.