The rising global energy demand and carbon emissions have galvanized researchers to explore alternative fuels. Over the past decade, significant attention has been devoted to harnessing abundant resources such as water and sunlight. Cobalt oxides are recognized as one of the most efficient earth-abundant catalysts for challenging oxidation chemistry, including the oxidation of water—a key step towards achieving a carbon-neutral future. However, the intricate structures of these oxides have hindered our understanding of their mechanisms. This presentation will discuss recent advancements in water oxidation mediated by cobalt-based catalysts and highlight the role of inorganic chemistry in addressing molecular-level questions and challenges. Insights gained may facilitate the fine-tuning of reactivity and stability in future synthetic catalysts for energy conversion and storage.