Given their highly porous nature and excellent water retention, hydrogel-based biomaterials can mimic critical properties of the native cellular environment. However, their potential to emulate the electromechanical milieu of native tissues or conform well with the curved topology of human organs needs to be further explored to address a broad range of physiological demands of the body. In this regard, the incorporation of nanomaterials within hydrogels has shown great promise, as a simple one-step approach, to generate multifunctional scaffolds with previously unattainable biological, mechanical, and electrical properties. Here, recent advances in the fabrication and application of nanocomposite hydrogels in tissue engineering applications are described, with specific attention toward skeletal and electroactive tissues, such as cardiac, nerve, bone, cartilage, and skeletal muscle. Additionally, some potential uses of nanoreinforced hydrogels within the emerging disciplines of cyborganics, bionics, and soft biorobotics are highlighted.