The frontier in solar energy conversion utilizing molecular and nanostructure components now lies in learning how to integrate functional entities across multiple length scales to create optimal devices. To address this new frontier, I will discuss our recent efforts on elucidating multi-scale energy transfer, migration, and dissipation processes with simultaneous femtosecond temporal resolution and nanometer spatial resolution. We have combined/correlated ultrafast spectroscopy with high spatial resolution techniques such as optical microscopy and scanning probe microscopy to achieve high-resolution spatial mapping of charge carrier dynamics in nanostructures and solar energy harvesting systems.