Nanowire is considered as one of the most ideal surface structure, because it shows superior light trapping effect in a broadband wavelength range. Although silicon nanowire solar cells (Si NWSCs) have excellent optical characteristics, they are difficult to enhance power conversion efficiency because of the severe surface recombination. In this study, we demonstrated a customized phosphorescent energy downshifting using Ir(III) complexes, to overcome poor absorption of Si NWSCs in a short wavelength range of 300 to 500 nm. The customized Ir(III) complexes are able to absorb short-wavelength photons (λ < 500 nm), for which the Si NWSCs exhibited low external quantum efficiency (EQE), and emit photons at longer wavelengths (λ > 500 nm). Furthermore, compared to the conventional quantum dot based downshifting materials, the proposed Ir(III) complexes have several advantages, such as high quantum yields, a larger stokes shift to prevent self-quenching, and a long diffusion length of minority carriers. With optimized conditions, our 1-cm² Si NWSCs with Ir(III) complexes exhibit a power conversion efficiency of up to 16.4 %, with an open-circuit voltage of 588 mV and a fill factor of 76.5 %. In particular, because of the efficient energy downshifting from Ir(III) complexes to the Si devices, our solar cells exhibit a two times higher EQE value for short-wavelength light (~450 nm), resulting in a notable increase (2.1 mA/cm²) in the short-circuit current density (36.5 mA/cm²) compared to that of bare Si NWSCs without Ir(III) complexes. Hence, we expect that this work would presents a unique opportunity to overcome the poor short wavelength photon absorption of nanostructure based solar cells.