We study ultracold atoms interacting with a surface at finite temperature. For the case where the surface is out of thermal equilibrium with the environment, the asymptotic form of the Casimir-Polder potential decays as an inverse square law and can be either attractive or repulsive, depending on the temperature difference. We analyze the effect of this interaction on the threshold law for quantum sticking, the probability that an atom will stick to the surface $s(E)$ as the incident energy E tends to zero. We predict a new threshold law for neutral atoms interacting with a surface out of thermal equilibrium with its environment: $s(E) \sim E^\gamma$ as $E \to 0$ ($0 \leq \gamma \leq 1/2$) where γ depends on the strength of the non-equilibrium Casimir-Polder interaction that may be tuned with temperature.