Traditional software transactional memory designs are targeted towards performance and therefore little is known about their impact on energy consumption. We provide, in this paper, a comprehensive energy analysis of a standard STM design and propose novel scratchpad-based energy-aware STM design strategies. Experimental results collected through a state-of-the-art MPSoC simulation infrastructure show that our approach can achieve an energy improvement of up to ~36% with regard to the base STM for applications characterized by short-lived transactions and relatively high abort rate.