In this thesis, we study the problem of throughput maximization in an energy-harvesting, two-hop, amplify-and-forward relay network. We obtain optimal policies for transmission power for offline and online settings. In the offline setting, we assume that non-causal knowledge of the harvested energy and of the fading channel states is available. We propose an effective algorithm to solve the power allocation problem in this case. Furthermore, using the method of Lagrangian multipliers, we present some properties of optimal power levels in the high signal to noise ratio (SNR) regime. For the online setting, we impose the condition that the information for the energy harvesting process and the fading channels is known only causally. In this case, we cast the problem as a Markov decision process (MDP). We also consider the case where power control at the transmitting nodes is limited to on-off switching and derive interesting properties for the optimal solutions to this special case. The MDP approach yields good performance, but at the cost of computational complexity. To address this issue, we propose a computationally simple power allocation scheme. In this method, the transmission power is chosen according to a simple threshold-based rule on the states of the source-relay and relay-destination channels. The performance of the proposed schemes are evaluated using computer simulations and are compared to existing methods which address the same problem.