Scavenging mechanical energy from the environment has been considered as a potential game-changing technology, especially for applications that require long-term, unattended operations of distributed devices, such as wireless sensors, wearable electronics, medical implants, etc. Because of the advantages such as high voltage output, low cost, and high electromechanical coupling, etc., electrostatic devices have been studied extensively. However, the efficiencies and energy densities of these devices are limited due to the small amount of charge involved as compared to the ultimate capacity of the material as determined by its dielectric strength. Here we report a method in which a positive feedback mechanism is intentionally introduced through reconfigurations of a scavenger fabricated with capacitors. Such mechanism creates instability on the charge in the scavenger so that any arbitrarily small amount of initial charge will grow exponentially. We fabricated prototype devices based on droplet capacitors. The results from low-frequency excitations confirm the exponential growth of the charge and the scavenged energy until the threshold of dielectric breakdown has been reached. The obtained efficiency was orders of magnitude higher than existing devices of similar dimensions. Under a 2.5 Hz vibration, a scavenger with three liquid metal drops can illuminate 60 commercial LEDs and with three water drops, it can illuminate 20 LEDs. Unlike the traditional methods, our method is not domain specific. We demonstrate that it can be generalized to other domains of energy.