

POWER: Persistent Optical Wireless Energy Relay, and DARPA's Pathway to Energy Web Dominance

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ABSTRACT

Energy is a fundamental currency in the battlespace. It is required to cause and transport military effects. Recognizing energy as a key aspect of warfare provides a new optimization surface to balance energy generation, storage, and distribution to more effectively achieve military objectives. In this way, generating and delivering military effects can be seen as an interconnected web of energy transactions. Dominating the energy web to more rapidly and reliably move energy through the battlespace and deliver military effects is the essence of warfare. DARPA perceives an opportunity to disrupt distribution by leveraging power beaming for near-instantaneous energy transport in a resilient, multi-path network. POWER (Persistent Optical Wireless Energy Relay) is a meaningful step toward building a new, more resilient energy distribution network.

By leveraging optical power beaming at high altitude for energy delivery over significant distances, DARPA will build the high throughput backbone for the wireless energy web. This will enable robust connections between secure energy sources and places of high need. Speed-of-light energy transport through a multipath network enables rapid reconstitution under attack, graceful degradation, and maximum resilience. As needed, energy can be rerouted through the network in a matter of seconds or minutes, and full capability can be restored by replacing nodes in minutes or hours. Furthermore, an established optical power network over a large geographical area allows for immediate redirection and focusing of military effects. This disruptive flexibility will enable a paradigm shift in tactics as commanders can pivot capability nearly instantaneously without reconfiguring supply lines. This is in stark contrast to the vulnerabilities and slow speeds associated with legacy liquid fuel-based supply lines.

POWER is the next critical step to enable energy web dominance by developing effective optical energy relays capable of creating the wireless multipath supply lines for distributed systems at meaningful ranges. While point-to-point power beaming continues to mature, relays unlock network capabilities for scalable range and energy throughput. High-altitude relays combine ground-based lasers with high-altitude beam propagation. This mitigates the thermal challenges of airborne lasers while also allowing for efficient long-range propagation through the thin, stable upper atmosphere.

Energy web transactions may also involve radio-frequency power beaming methods for transferring or relaying energy. This can permit distribution to locations that have line of sight limitations due to foliage, weather, or other optical obscuration while also offering other advantages for shorter-range applications. Additionally, sources of energy that are currently impractical to reach, such as remote ocean wave, wind, and solar installations become available unlocking cleaner means to power societal productivity. Ongoing and future planned work will explore architectures that combine the benefits of various power beaming modalities within a coherent energy web framework. Ultimately DARPA envisions a future where energy can be seamlessly and autonomously flowed through this network flexibly connecting abundant sources to energy starved consumers.