ELECTRICAL, ELECTRONICS AND COMMUNICATIONS ENGINEERING

DET - Laser technologies for wireless power transmission in space

Funded By	Dipartimento DET
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Context of the research activity	The return of humans to the Moon requires advanced engineering solutions to ensure the sustainability of future missions. One of the key challenges is the reliable transmission of energy in extreme environments where conventional power sources are limited. Laser Wireless Power Transmission (LWPT) is emerging as the most promising solution to provide power to rovers, habitats, and other surface systems.
Objectives	The activity, partly conducted within a project funded by the Italian Space Agency (ASI), aims to develop technologies for laser wireless power transmission to enable energy delivery to permanently shadowed regions of the Moon, such as polar craters, and to support operations during extended lunar nights. These environments pose limitations for conventional power generation and distribution systems, motivating the investigation of alternative approaches for energy transmission to support long-duration lunar exploration and infrastructure. In more detail, the activity focuses on the design, development, and integration of the main components of a laser wireless power transmission system, including high-efficiency laser sources and beam shaping, steering, and pointing subsystems. The work aims to improve system performance by increasing transmission efficiency while maintaining robustness and operational reliability. Specific attention is given to challenges related to operation in the space environment. These include mass reduction, thermal management of high-power laser systems, and improvement of energy conversion efficiency at both the transmitting and receiving ends. The activity also addresses the effects of radiation on optical components and materials, as well as long-term degradation processes that may affect system lifetime and performance. Safety aspects relevant to both spaceborne and ground-based assets are considered in the system design and in the definition of operational concepts.
Skills and competencies for the	The activity requires background knowledge in optics, photonics, and electromagnetic wave propagation, with particular competence in laser

for the development of the activity	systems, optical system design, and beam shaping. Familiarity with both numerical modeling and experimental laboratory work is expected.