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# WHAT IS NUCLEAR POWER'S NICHE IN DEEP SPACE MISSIONS?

**Abstract**

Power requirements for deep space and planetary science missions vary by mission function, mission destination, and mission duration. At present, power needs for space missions have been fulfilled by a combination of solar, chemical, and nuclear sources. This paper presents space power options for near-term future missions via a requirements-driven approach (i.e., through a demand pull). A study of options for power generation for a range of mission functions was conducted along with a review of select mission architectures of interest to assess the relevance and potential place of nuclear power in the space enterprise.

Mission architectures reviewed included both outer and inner solar system missions as well as robotic and human missions. Generalized technical assessments of potential power sources were then made to see how each option might fit into mission and function needs. One initial finding was that mission architectures are sometimes driven to make power selections based on cost and bureaucratic complexities instead of optimal science goals, which can lead to underrepresented power requirements.

Solar and chemical power options suffice for many robotic missions that are within a certain distance from the sun. While both these power options are reliable and have a well-established space heritage, there are two notable instances in which nuclear plays a mission-enabling role. The first of which is when the mission is to areas where solar flux is too low for solar to be considered. The second case is where power levels required for the mission are very high, for example providing surface power for human and robotic activities on Mars or propulsion for human space flight missions where it is important to reduce transit time to minimize human exposure to cosmic radiation.

A lack of mature technology to support high-power levels over longer duration missions presents a third area that could potentially be filled by nuclear power. While higher power radioisotope systems and fission systems, technologies that could fill this gap, are being investigated, investment costs are high and disagreements within the technical community have prevented real progress on either front.

While nuclear power can enable science goals, other considerations such as safety concerns, schedule risk, and high cost can restrict implementation of nuclear power on missions. Additionally, mission architects believe that they have more direct control over solar power development compared to nuclear power, which affects selections for missions.