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Sustainable Approaches and Impact of Space Transportation Solutions on Earth + Space Environment and on General Safety (9-D6.2)

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ADVANCING LIFE CYCLE ASSESSMENT AND ECODESIGN FOR SUSTAINABLE SPACE TRANSPORTATION: LESSONS LEARNED, INDUSTRY COLLABORATION, AND THE PATH FORWARD

Abstract

The European Space Agency (ESA) aims to address critical societal needs with its space programmes, while championing responsible space activities. In its strategy towards 2040, the Agency aims to minimise the environmental impacts of its own operations, both on Earth and in space. With over a decade of experience in conducting life cycle assessments (LCAs) of its space programmes in collaboration with industry partners, ESA has focussed on identifying environmental hotspots and ultimately integrating eco-friendly solutions into mission design. The launching phase being a significant environmental hotspot, it has been the focus of several studies, both from a methodology and technical solutions development point of view. The ecodesign approach starts with a complex data gathering process, followed by a comprehensive modelling and analysis of environmental impacts throughout the life cycle of each space mission. A cornerstone of the ESA's LCA and ecodesign approach is the development tailored methodology and database specific to the unique challenges of space projects. ESA is committed to guiding the space ecosystem in this effort, aiming to streamline the process for all stakeholders, from direct suppliers to distant links in the supply chain. To this end, a working group was created comprising ESA and partners from the space ecosystem (e.g. academia, industry). This collaborative effort focuses on co-developing best practices in data collection, experts' trainings, LCA delivery, reporting, and ecodesign solutions. The insights gained directly inform the ongoing update of the ESA space system LCA guidelines, providing a robust framework for conducting space-specific assessments. A notable enhancement in the recent guidelines update is the introduction of a simplified LCA approach. This innovation is crucial for performing high-level LCAs in early phases of projects, enabling the identification of ecodesign solutions in a cost-effective way, when design options are still flexible. Dedicated tools are being developed, some being specific to launchers. The article will delve into the challenges of conducting LCAs for space missions, and explore how ESA and space industry partners are collaborating to make this process more efficient. From simplifying data collection to developing comprehensive guidelines for simplified LCAs and fostering

a collaborative working group, the European space sector is paving the way for a more sustainable future in space exploration.