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Title

Can Regulatory Actions Guide or Dictate Sustainability in Space?

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Abstract

The need for sustainability and material circularity is not limited to human activities on Earth, and in fact, have broad implications for the utilization of outer space. The space industry is rapidly growing and the number of objects in space increases the pressure to act sustainably. Driven by technological advancements, the reuse of space hardware and circularity in space are becoming feasible and alternatives to the disposal of spacecraft. Actors in government, academia, and industry alike are exploring circular economy principles as a path to space sustainability. The Circular Economy, and a circularity perspective relate to Earth where it can be assumed that circular strategies like upgrading, repairing, remanufacturing, and reusing of components can mostly be applied across industries, the question on the applicability to the space domain remains largely unanswered. In addition, the space environment puts complications to circularity approaches from technical, financial, and legal points of view. Nonetheless, enabling the reuse of space hardware is a key challenge for space exploration with broad implications on the sustainable human future in space. The technology to collect, process, and reuse space hardware is either missing or in early development stages. With this, most satellites that are currently launched will likely be disintegrated and burned up in Earth atmosphere by the end of their life cycle, with largely unknown long-term atmospheric and environmental effects. Legal frameworks and regulatory actions have long been considered as both, drivers and accelerators for technological advancements and innovations. This paper investigates how regulatory actions can incentivize the development of missing technologies and the implementation of circular material flows in space. It aims to provide an overview on regulatory actions and best practices to incentivize reusability and circularity in selected industries with the goal to identify, analyze, and map successful implementations for space. To understand whether sustainability in space can be guided or even dictated with regulatory actions, existing regulatory actions based on the Sustainable Development Goals, carbon emission reduction and electrification in automobiles, and implementing sustainable production across industries are examined. This research argues to to incentivize innovations for circular material flows in space, adequate regulatory actions and rules need to be established. For this, Sustainable Development Goals (SDG), the Space4SDG initiative, adding a separate, space focused SDG18, or the Net-Zero Coalition can be examples or act as blueprints, but targeted and sometimes enforceable regulatory actions are needed to create positive results. This research attempts to start the conversation on the need to consider and to start implementing regulatory actions to incentivize not only reusability of space hardware or to implement circular material flows in space but also to build a foundation for sustainability on Earth and outer space.

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