

IAF SYMPOSIUM ON SECURITY, STABILITY AND SUSTAINABILITY OF SPACE ACTIVITIES  
(E9)

## Norms and Standards for Safe and Responsible Behaviour in Space (3)

Author: Mr. Bernd M. Weiss  
Luleå University of Technology, Sweden

Prof. Rene Laufer  
Luleå University of Technology, Sweden  
Prof.Dr. Anna Ohrwall Ronnback  
Luleå University of Technology, Sweden

## REGULATORY ACTIONS AIMING FOR INCREASED SUSTAINABILITY

**Abstract**

The space industry is rapidly growing and the number of objects in space increases the pressure to act sustainably. Actors in government, academia, and industry alike are exploring circular economy principles as one path to space sustainability. Referring to the Circular Economy and circular economy principles, in most cases, means to apply the various approaches on Earth, where it can be assumed that the circular strategies like upgrading, repairing, remanufacturing, and reusing of components can be applied across industries. Extending the perspective to outer space, the applicability of circular strategies on space hardware, with additional complications due to the space environment, remain to be seen. Most satellites and spacecraft that are currently launched are designed to be disintegrated and burned up in Earth atmosphere by the end of their operational life cycle. This is leading to valuable materials being unrecoverable but also has largely unknown long-term atmospheric and environmental effects. The reuse of space hardware can be seen as a key challenge for the space industry, with broad implications on space exploration, space and environmental sustainability, and a sustainable, long-term human presence in space. In many fast-innovating industries, regulatory actions have long been considered as supportive drivers accelerating technological advancements and innovation.

This research takes on this notion and investigates if, and how, regulatory actions can incentivize the development of global sustainability standards, missing technologies, and the implementation of circular material flows in space. To understand whether sustainability in space can be guided or even dictated with regulatory actions, examples of regulatory actions related to Sustainable Development Goals, carbon emission reduction and electrification in automobiles, and implementing more sustainable production across industries are examined in a first step. It will then be attempted to map the findings to space industry products and examined how design and the production of spacecraft are enablers for reusability. Consequently, this research argues that to incentivize innovations for circular material flows in space, adequate regulatory actions and rules can be supportive. Sustainable Development Goals (SDG), the Space4SDG initiative, the Zero-Debris Initiative, and the Net-Zero Coalition can be taken as examples and act as blueprints, but also regulatory actions that are enforceable should be considered to create positive results. With this research we aim to start the conversation about the pressing need for space sustainability and to urgent call for regulatory actions to incentivize reusability of space hardware and enabling circular material flows in space.