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Emerging Space Ventures, including Space Logistics and Space Safety for Sustainability (9-D6.2)

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## DEVELOPMENT OF A LAUNCH VEHICLE SUSTAINABILITY RATING

### Abstract

The largest contributors to debris risks on orbit are mission-related objects created by launch vehicles<sup>1</sup>. Passivating and deorbiting upper stages are thus critical to safeguard valuable orbits, even more since some are left on orbits that are crossing crowded LEO and GEO, threatening operating satellites. The number of launches per year is bound to increase in the coming years with the democratization of the access to space. This will increase material consumption and emissions, especially during launch events, directly in all layers of the atmosphere.

After the successful development of a space sustainability rating (SSR), getting operationalized in 2022 by the EPFL Space Center, a new formulation focusing on the sustainability of launch vehicles is proposed. The Space Sustainability Rating is a notation system that allows one to characterize the impacts of a space mission and highlight areas of possible improvements. The idea of a launch vehicle sustainability rating (LVSr) emerged from discussions about SSR with different stakeholders in the space domain, and is motivated by several facts. In the same mindset as SSR, the goal will be to incentivize launch providers to make sustainable design and operational decisions, to limit environmental impacts and space debris risks.

This paper will describe the process followed to elaborate the first version of this new rating. First, a list of significant parameters to account for is described and discussed. The parameters cover all phases of the launch vehicles' life cycles and allow to certify different architectures depending on their impacts on the space's and Earth's environments, including the atmosphere. Secondly, these impacts are grouped in five technical modules and LVSr takes advantage of the verification strategy already used in SSR. A module focuses on sustainability on Earth, with a score based on a quick life cycle assessment study. Other modules follow the general concept of operations of a launch vehicle by assessing the ascent trajectory (including jettisoned parts and burning of fuel), the orbital stage (including mission-related objects, disposal and passivation strategies), and the reentry phase (including the demisability percentage). A last module rewards launch service providers' transparency and adhesion to international guidelines. Finally a formula to grade a launch vehicle by aggregating the modules' score will be developed. Next steps will be to validate the rating by applying it to beta tester vehicles.

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<sup>1</sup>As assessed by ESA's mission index in : ESA Space Debris Office. "ESA's Annual Space Environment Report" (2021).