27th SYMPOSIUM ON SPACE POLICY, REGULATIONS AND ECONOMICS (E3)
Poster Session (P)

Author: Mr. Francesco Leonardo Consonni
Politecnico di Milano, Italy, francesco1.consonni@mail.polimi.it

Ms. Beatrice Buffa
Politecnico di Milano, Italy, beatrice.buffa@mail.polimi.it
Mr. David Albert Dianda
Politecnico di Milano, Italy, david.dianda@mail.polimi.it
Mr. Filippo Manelli
Politecnico di Milano, Italy, filippo.manelli@mail.polimi.it
Mr. Massimo Molinelli
Politecnico di Milano, Italy, massimo.molinelli@mail.polimi.it
Mr. Davide Pizzocri
Politecnico di Milano, Italy, davide.pizzocri@mail.polimi.it
Mr. Mauro Massari
Politecnico di Milano, Italy, mauro.massari@polimi.it

GREENSPACE: TOWARDS A SYSTEMATIC, GLOBAL AND INNOVATIVE EVALUATION OF THE ENVIRONMENTAL IMPACT OF SPACE ACTIVITIES FOR A SAFE AND SUSTAINABLE SPACE ENVIRONMENT

Abstract

ESA has recently decided, through the Clean Space program, to begin a systematic assessment of the environmental impact of its activities. The reasons lie in the increasing environmental awareness, in the emanation of new and stricter regulations on industrial processes and in the fact that the impact of space activities has never been methodically evaluated. The present work has been developed in this frame: its goals are to define the idea of sustainability for space activities, to develop innovative methods to evaluate their impact and to propose a more environmentally-friendly design solution to mitigate their effects in one of the many stages of their life cycle. The first task was carried out starting from the definition of sustainability given by Gro Brundtland and performed by adding sustainability drivers related to "space waste", further divided into the subdrivers "room availability" and "risk of collisions". Moreover, a distinction between "absolute green technologies" and "relative green technologies" has been proposed. As for the second objective, the eMergy approach, holistic and simpler than LCA methods, was adapted from ecology and used to identify the critical subsystem of a space launcher. The criticality analysis shifted the focus on the propellants, which were further analyzed through a specifically tailored qualitative method, Fuel Life Environmental Cycle Assessment (FLECA). The use of this method led to the identification of the hydrogen production for Ariane launchers as one of the most significant environmental hotspots. Six alternatives to mitigate the carbon dioxide emissions caused by the hydrogen-producing plant were proposed. After a preliminary evaluation of their effectiveness, a Multi-Criteria Decision Analysis (MCDA) method, TOPSIS, was applied to find the optimal solution, considering also the criteria of adaptability to the plant, maturity of the technology and cost. The production of hydrogen from biomass-derived methanol, paired with carbon capture, turned out to be the best option, mainly because of the significant reduction in specific CO2 emissions it generates. In conclusion, the present work has given new perspectives and new insights on the evaluation of the environmental impact of space

activities, in order to create a safe and sustainable space environment. The adopted method is systematic, global and multidisciplinary: rigorous definitions have been given and framed in the scientific literature, launches are not seen as singular events, but as occurrences that have extended influence in space and time, and frontier developments from other fields of engineering have been adapted to the space field.