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

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ROADMAP TOWARD A GREENER KICK-STAGE PROPULSION SYSTEM

Abstract

The boom of the modern space arena puts Europe under steady market pressure to stay the course. To keep up, innovation in developing the Future European Launchers portfolio is key. This step is based on the three major axes highlighted by ESA: competitiveness, versatility and diversification. While competitiveness aims to lower the cost of each launch by adopting a more end-to-end approach, versatility and diversification allow to fulfil a wider range of missions by promoting novel technologies. Among those, green propellant and electric-pump feeding system stand out as a potential game-changing opportunity in terms of simplicity, performance and reliability. Indeed, when compared to the two classic pressurization systems, given certain boundary conditions, the e-pumps already bring higher performance than pressure-fed systems and lower complexity than turbopumps. In the same vein, replacing the use of toxic storable propellants by green ones would simplify and lower the cost of space access by possibly reducing the handling and storage protocols currently required on ground. The exemption granted to the space industry since 2011 for using hydrazine will eventually encounter a sunset date; hence providing a formal incentive to the development and integration of green propulsive systems for future launchers. In this modern space era, an innovative type of spacecraft, known as kick-stage, is currently striking its own path by offering a new range of services, such as the ASTRIS kick-stage currently developed by ArianeGroup. Looking ahead, the LunaNova kick stage, also studied by ArianeGroup via the FLPP program, is already integrating green propellant and e-pumps for future kick stage applications. This paper first presents the specific trade-off study performed within LunaNova to identify the most suitable fuel in combination of HTP for LunaNova application. This trade-off, focused on cost and performance, is then extended to our early kick stage study which already highlighted the benefits of switching from pressure-fed toxic propellants to an e-pump HTP/propane propulsion system. The propellant selection is now refined from a wider scope and the implications of the system are drawn. The final cost-estimation established for

each HTP/fuel combination will be decisive for concluding the trade-off. Then taking into consideration the LunaNova mission analysis, the foreseen operations and the definition of the different system layers, conclusions are drawn and a preliminary design roadmap of the kick stage propulsion system is proposed.