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ESG and CSR in Space
Semester Project Final Report

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LCI Life Cycle Inventory 20

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LCC Life Cycle Costing 15

SDG Sustainable Development Goals 7

GRI Global Reporting Initiative 11

CDP Carbon Disclosure Project 11

CSRD Corporate Sustainability Reporting Directive 16

SFDR Sustainable Finance Disclosure Regulation 19

ESA European Space Agency 6

NASA National Aeronautics and Space Administration 9

ESO European Southern Observatory 7

ESTEC European Space Research and Technology Centre 18

LEO Low Earth Orbit 4

2 Introduction

In an era marked by a surge in space activities, this project explores the integration of Corporate Social Responsibility (CSR) and Environmental Social and Governance (ESG) principles within the space sector. As private companies and space agencies embark on ambitious ventures, understanding how CSR and ESG frameworks can be tailored to the unique challenges of the industry, and how they can fit within existing sustainability practices becomes imperative.

Corporate Social Responsibility (CSR) refers to sustainability objectives defined by a company to guarantee positive societal and environmental impacts, and ensure the business is carried out ethically. These objectives are then integrated into the business' strategy, and shape the company's operations, processes, products, and management style. Additionally, CSR objectives should be trackable in time for comparability purposes and quantified. Having a well defined CSR objective prevents greenwashing [1], which is defined by the United Nations as "misleading the public to believe that a company or other entity is doing more to protect the environment than it is."

An example of a well defined CSR objective for a satellite producer is: "Our company aims to achieve a 25% reduction in satellite collisions with debris in Low Earth Orbit (LEO) by the year 2030."

Environmental Social and Governance (ESG) is a criterion used to measure a company's overall sustainability performance according to the three pillars E, S, and G. These measurements are increasingly demanded by stakeholders and investors and are a way for the company to report on their CSR objectives in a standardized format. Companies are thus held accountable for their sustainability claims, making repercussions for noncompliance severe, such as facing fines that can affect publicity and revenue. Different ESG criteria corresponding to the three pillars can be seen below.

With space activities increasing both in frequency and amplitude, it is becoming critical to integrate CSR and ESG in the space sector, to ensure both space agencies and private companies behave in a responsible way. Private companies such as SpaceX (Starlink), Amazon (Project Kuiper) or OneWeb are in the process of deploying large constellations of satellites in LEO to provide global broadband internet coverage. With over 21'000 space debris objects [3] already orbiting the Earth in low orbit in 2020, controlling the injection of new satellites, and limiting collisions that could increase the space debris count becomes crucial. Other emerging trends such as space tourism and human settlements on celestial bodies such as Mars are being led by SpaceX and Blue Origin, and need to be regulated to ensure they are acted upon in a socially and environmentally responsible way. Thus, space

Figure 1: ESG pillars [2]

actors incorporating ESG and CSR practices is imperative to ensure environmental protection, social equity, and ethical governance both on Earth and in space.

The adoption of comprehensive CSR and ESG frameworks can guide companies towards a responsible and sustainable business conduct. Concurrently, the integration of sustainable considerations into product development and operational processes is gaining prominence and is a necessary step in applying company-defined objectives into products and processes. **Life Cycle Assessment (LCA)** is a key tool used to evaluate a product's environmental impact throughout its life cycle, providing insight into environmental impacts from the extraction of raw material to marketing and distribution of the product. Moreover, as human activities expand in space, the concept of **acSSR** [4] developed at EPFL's eSpace center has emerged, allowing companies to rate their environmental impact and product reliability in space. CSR and ESG can contribute to the integration of these sustainability practices, by implementing SSR into the Environmental pillar of ESG, and using CSR objectives as context to understand the sustainability impacts associated with a product or process when conducting an LCA.

In this research project, we focus on **how CSR and ESG can be tailored to fit different levels of the space industry supply chain in Europe**. Focusing on the size of the company and its location on the supply chain is necessary, as small companies tend to have less funds to allocate in implementing sustainable practices, while large companies have more resources and complexity to account for when reporting their impacts. Moreover, the CSR objectives of a company will differ depending on whether they are suppliers of electronic components, with their most significant impact on Earth, or a rocket launcher producer, with environmental implications both on Earth and in space. Thus, the aim of this project is to

understand existing ESG and CSR reporting frameworks, and study how they can be adapted to companies in the space sector.

3 Methods

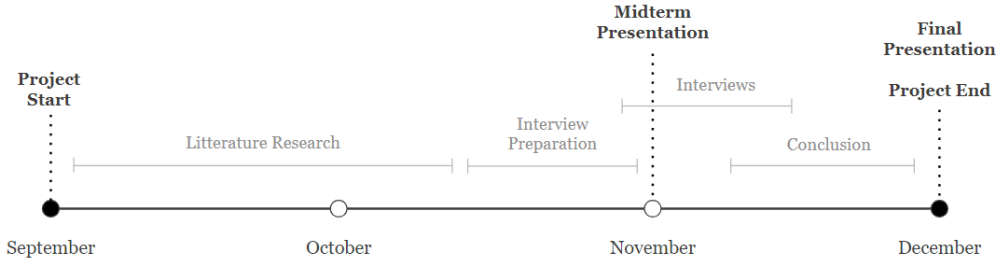

Figure 2: Project Timeline

This research project has been conducted over the span of 3 months, starting late September and ending in December. To ensure a comprehensive understanding of the key notions of ESG, CSR, LCA and SSR, the first two months of the project were dedicated to literature review and studying existing implementations of these concepts in the space sector. In mid-October, I was able to gather enough relevant information regarding the thesis question to formulate a study plan. This included interviewing three active actors in the space sustainability sector to gain their perspective on the integration and adaptability of ESG and CSR in the European space industry supply chain.

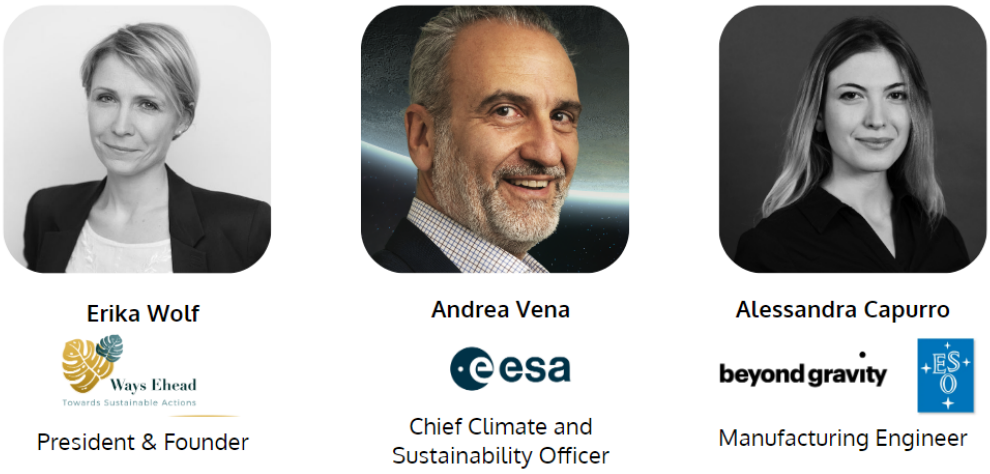

Figure 3: Interview Participants

The first interview participant, **Mr. Andrea Vena**, is the Chief Climate and Sustainability Officer at the European Space Agency (ESA). Appointed in 2021, he

oversees the elaboration and implementation of the ESA Green Agenda [5], which establishes actions for overcoming climate and sustainability challenges, in line with the Paris Agreements on Climate Change [6]. He is now also working on the 2024 release of the ESA Code of Conduct [7] to its industrial chain of over 11'000 suppliers, which details CSR objectives that should be adopted by companies working in partnership with ESA. These objectives range from human rights to environmental management and information protection.

The second interview participant was **Ms. Erika Wolf**, who is the President and founder of Ways Ehead [8], a consulting company focused on the implementation of sustainable actions. Ms. Wolf works closely with a diverse range of companies, ranging from startups to large corporations. Her role involves providing guidance on the feasible implementation of CSR reporting frameworks. She also assists in the formulation of a clear set of CSR objectives that align with the company's budget and impact goals. This strategic approach aims to steer the company toward ethical conduct.

The third interview participant was **Ms. Alessandra Capurro**, who has been working as Manufacturing Engineer at Beyond Gravity since 2022. Ms. Capurro is working on the production of space mechanisms, such as Solar Array Drive Mechanism (SADM), while pushing to integrate sustainable practices such as an LCA of Beyond Gravity products. Before this position, she worked at the European Southern Observatory (ESO) as Environmental Engineer, performing the LCA of the Very Large Telescope located in Chile and announcing carbon audits for the organization.

All three interview participants possess diverse backgrounds within the space industry, providing a range of perspectives on my thesis question. Their expertise in their respective fields proved invaluable in exploring different aspects of how companies can integrate ESG and CSR. Mr. Vena offered a high-level perspective on objectives, Ms. Wolf provided insights into the direct application of sustainability practices, and Ms. Capurro offered a view from inside ESA's supply chain.

The mid-term presentation was held in November. The literature review carried out in the first half of the semester was presented, along with the learning objectives expected from the three interviews. In mid-November, the interviews were concluded and a conclusion to the thesis question was formulated. The research project ended in December, with the final presentation where results were discussed.

4 Notions

4.1 Corporate Social Responsibility (CSR) in the space sector

In present days, CSR initiatives are becoming increasingly demanded by stakeholders [9], as contribution to the United Nation's Sustainable Development Goals (SDG). Reporting back on the evolution of those sustainability objectives is crucial to main-

taining transparency and providing evidence that the company is putting effort into complying with their defined objectives. Companies who do not provide relevant data to support their CSR objectives or who focus on the wrong elements face the risk of being accused of greenwashing. This might result in implications for future funding search and might sever the trust vested in them by their stakeholders. Conversely, proving that the company is working actively towards their CSR objectives might improve the brand's reputation, and facilitate the search for funding.

As the space sector continues to expand towards new areas of activity such as mining on asteroids, the establishment of human settlements on Mars or the deployment of new satellites constellations, it is becoming crucial to implement a socially responsible mindset in the private and public space sector. The space industry poses unique dilemmas such as back contamination, resource distribution and heritage of findings in space, to which terrestrial industries are not confronted to. Ethical questions such as the proprietors of materials gathered in space, and territorial distribution on celestial bodies are still unclear. The International Space Law states in Article 11 of the Moon Agreement [12] that "The moon and its natural resources are the common heritage of mankind". With the expansion of space-related activities, present legal gaps need to be filled in by responsibilizing companies with CSR.

Corporate activity in space has a diverse range of foreseeable impacts. The integrity of celestial bodies may be compromised due to space debris. Even the little research conducted to date has caused pollution on the Moon, Mars, and Venus, as rovers and landers are discarded when reaching their end of life. Future endeavors such as terraforming and mining could destroy small scale asteroids and celestial bodies. This raises questions of whether celestial bodies should receive the same amount of environmental protection as the Earth. Furthermore, socio-economic impacts can be caused by markets expanding beyond Earth through space mining, which would be disruptive for terrestrial enterprises and price of commodities. Additionally, the effects of long term travel in space and space tourism are still uncertain, leading to risks related to psychological welfare.

Private space companies are not mentioned in existing international treaties concerning commercial activities in space [10], meaning governments are responsible for the conduct of their private space sector. This is comparable to extraterritorial regulations of transnational corporations on Earth, which is limited with regard to controlling adverse environmental and human rights impacts. As financial returns from the space industry are already insecure, this makes the voluntary protection of the environment with directed funding highly unlikely.

As Dr. Thorbjørn Lundsgaard's article *"CSR in Space: Corporate Social Responsibility Principles for the Space Industries"* states [11], it would be of interest to follow existing CSR guidelines and apply them to space. Some relevant objectives presented include health monitoring of participants of any space activity, psychological health, mitigation of space debris, environmental protection, transparency in communication and accountability to the companies' home government.

At first sight, it seems that convincing companies in the space industry supply chain to invest funding and research efforts in CSR seems to be more difficult than for terrestrial companies. As an example, electronics components suppliers located at the bottom of the supply chain are not aiming to gain a favorable public opinion by implementing CSR objectives, as their business interactions are mainly done with industrial stakeholders. For this reason, it's important for the stakeholders located at the top of the supply chain (ESA, the National Aeronautics and Space Administration (NASA)) to set sustainability objectives, standards, and a vision for the future of the sector. CSR should also be adapted to the location of the industries in the supply chain: a mixture of space and terrestrial CSR should be integrated in companies working in direct contact with the space mission (eg. launcher manufacturer), whereas only terrestrial CSR would be sufficient for companies with no link to the mission itself (eg. supplier of non space-grade components for prototyping).

On the 25th of October 2018, **ESA held a CSR workshop** [13] with key suppliers to raise awareness on the need for CSR. The objective of the workshop was to target common sustainability goals and step up CSR efforts to improve its image in the space sector. Eleven representatives attended, and ten did not. Among the attendees were CSR officers and eco design representatives from Airbus, OHB, Leonardo, Ariane Group and Deloitte.

The first part of the workshop was dedicated to a personal evaluation of ESA. Participants expressed that there was too much bureaucracy and little communication with ESA, there needed to be more funding directed towards CSR, and that the existing silo mentality within their companies was strong, leading to difficulties in achieving long term goals. Participants expressed strong expectations of ESA organizing by concrete actions the European space sector around a common vision of CSR, goals, targets, and strategy. It becomes clear ESA is expected to organize a governance system for the European space sector, taking care of funding, objectives, and remedying communication issues.

The second part of the workshop was an oriented discussion towards ideas for CSR objectives. One of the proposed objectives was "A vision and road map to settle outside Earth". This would bring positive social impact by inspiring the public and recruiting new talent, but negative environmental impact on targeted celestial bodies. The ongoing MELiSSA (Micro Ecological Life Support System Alternative) project was brought forward as well. This closed loop artificial eco system for long term human missions brings positive social impact as it could be deployed on Earth during humanitarian responses. It also pushes the boundaries of knowledge, could give an understanding of the Earth as a closed loop system, and study environmental issues such as pollution.

The outcome of this ESA workshop demonstrates the supplying companies' willingness to invest time and resources in meeting CSR objectives, and a need for ESA to lead the effort towards building a vision for future missions and objectives, and

to improve the frequency of communication with suppliers. While it is difficult to address every company in ESA's supply chain, the communication aspect is critical if objectives are to be adopted efficiently and reported on.

To better understand how companies report on their CSR objectives, **the CSR reports from RUAG and ESA** were analyzed. RUAG is a Swiss company specializing in aerospace engineering and the defense industry. Their space-oriented segment is Beyond Gravity [14]. RUAG's latest CSR report [15] dates back to 2020, and largely focuses on COVID-19 risk mitigation. Their missions are described in the table below. As can be seen, they report on the company's social and environmental achievements rather than focusing on self-defined objectives set in time. While it's a good first step towards focusing on sustainable practices, having a lack of quantitative objectives can be detrimental to the company on the long run, as they may be accused of greenwashing for solely focusing on their positive contribution to society while neglecting to work on their negative impacts. RUAG has not issued other CSR reports since 2020, making it difficult to measure the evolution of the company's impact mitigation, and to hold them accountable for their sustainability-oriented actions. On the other hand, ESA's 2022 CSR report [16] demonstrates clear objective-setting, with main objectives displayed in table 2. Their missions are sorted under the categories of contribution of space to society, governance, managing our environmental responsibilities and human resources & social responsibility. This covers every main ESG pillar, and makes it easy to track and report to stakeholders under an ESG framework.

4.2 Environmental Social and Governance (ESG) in the space sector

ESG is defined as a set of criteria used to measure a company's overall sustainability, with respect to the Environmental, Social and Governance pillars. Nowadays, ESG reporting is becoming increasingly demanded by investors and other stakeholders, as it makes companies accountable for their sustainability claims, and prevents issues with greenwashing. The path to incorporating ESG starts with the business conducting a materiality assessment, collecting insights from stakeholders, setting CSR goals, and conducting a gap analysis. Following these steps, the company can then develop a measurable road map, retrieve Key Performance Indicator (KPI) and report their progress back to stakeholders through ESG reporting.

Within the space industry, space ESG strategies related to the environmental impact in space are generally considered to be for large companies, as ESG engagement costs can be challenging to meet. Startup cash must be carefully targeted to core needs, and the near-term financial returns on ESG are not guaranteed. While focusing on the environmental aspects of ESG can require significant resource allocation, social and governance aspects are equally important, and require less funding to verify. For this purpose, it may be beneficial for startups and small enterprises to start by identifying their impacts related to those two pillars to get started on

RUAG CSR Report (2020)	
CSR Action Title	**Actions Taken**
Employees get involved	Due to COVID, employees got together to collect and distribute food, and donated blood and plasma at the Defence Blood Challenge. Active support for the visually impaired was also provided by the workforce in Malaysia. RUAG Australia held fundraising activities with charitable organizations.
Promoting the fascination of space	RUAG Space supported the Swiss Museum of Transport to provide the "Space-Experience".
Refurbished not discarded	Collaboration with the non-profit organisation AfB social and green IT. Refurbished used PCs and laptops
Improvements to the environment	The manufacture of RUAG Ammotec commissioned as extension to its own wastewater treatment plant and a filtration plant at the DE production site, where part of the chemical wastewater is being pre-treated. The treated wastewater can be discharged into surface water body. This means that around 12000 cubic meters of treated wastewater can be reused for production purposes.
Fewer accidents	Reported work accidents per 1000 full-time positions fell to 18 cases in 2020 (24 the previous year).
Together against coronavirus	RUAG Ammotec supported the city of Furth with disinfectant and protective masks. A total of 200 litres of surface disinfectant was produced in-house and 1000 FFP2 masks went to public facilities such as daycare centres and retirement homes in the city.

Table 1: Summary of RUAG's CSR Report (2020) [15].

reporting, before focusing on the environmental pillar.

ESG reporting is done through standardized frameworks such as the Global Reporting Initiative (GRI), the Carbon Disclosure Project (CDP), the United Nations' Sustainable Development Goals (SDGs), the Carbon Footprint Measurement and ISO certifications. In this section, we will focus on widely used frameworks and frameworks related to space.

GRI [17] is a comprehensive modular system comprising of three series of standards: the GRI universal standards, the GRI sector standards and the GRI topic standards. Although there is no account for the space sector, the existing regu-

ESA CSR Report (2020-2021)	
CSR Action Title	**Actions Taken**
Contribution to society	Current and upcoming projects include improving Earths atmospheric models by studying the atmosphere of Mars, the Galileo emergency warning service which broadcasts alert messages to populations facing threat or disasters, monitoring and understanding the impact of the COVID-19 pandemic on society and ESA's education program.
Governance	The internal governance at ESA is detailed in the report, along with ESA's compliance with local laws and regulations, ethics, brand values and responsible communication. Additionally, an Environmental Protection Working Group and a Yong Professionals Advisory Group have been set up to achieve common goals and encourage open exchange in the Agency.
Managing our environment responsibly	The report details the environmental management of ESA's facilities, assessing and tackling the environmental impact of ESA space activities through Clean Space, SSR, and studying the impact of chemical regulations on the European space sector.
Human resources and Social Responsibility	ESA explained their implementation of strategies to mitigate the impacts of COVID-19 on their employees, their 2021 Astronaut selection campaign which included a parastronaut feasibility project, and the diversity and inclusiveness of the agency.
Relations with partners and suppliers	This includes ESA's relations with stakeholders and responsible procurement following ISO 20400:2017.

Table 2: Summary of ESA's CSR Report (2020-21) [16].

lations can be adapted. The GRI standards contain disclosures, which provide a structured means for an organization to report information about itself and its impacts. The disclosures contain requirements and can also include recommendations. GRI's universal standards provide a foundation for all GRI reporting, and cover topics such as governance, strategy, and management approach. Sector standards provide additional guidance for organizations in specific sectors, such as agriculture, manufacturing, and financial services. Finally, topic standards provide detailed guidance on specific topics such as climate change, human rights, and corruption. While GRI covers a wide range of topics, it can also be complex to implement as it requires a significant number of resources and expertise to implement effectively. It

is also a voluntary framework, and without government intervention, GRI does not have the authority to enforce its reporting requirements or penalize organizations that report inaccurately.

The **SDGs** [18] are a set of 17 goals proposed by the United Nations in 2012. Some of these goals are highly relevant in the space sector and can be adapted to fit the sector's needs. The goals include but are not limited to good health and well being of workers, gender equality, clean water and sanitation, clean energy, innovation in the industry, climate action and reduced inequalities. A specific framework for the space industry based on the SDGs does not exist yet, as frameworks such as GRI and ISO certifications are already well suited. However, SDGs remain a basis for creating CSR objectives within a company.

ISO 14001 [19] and **ISO 26000** [20] are both certifications I have encountered during my research and interview discussions. ISO 14001 is a set of criteria for environmental management systems, and can be applied by any type of organization, regardless of their activity and sector. It covers environmental labelling, LCA, environmental performance evaluation, greenhouse gas and climate change management. ISO 14001 provides a clear set of standards, that provides a systematic approach easy for companies to implement. Meanwhile, ISO 26000 is a guidance standard focusing on social responsibility. ISO 26000 comprises of a set of guidelines as opposed to requirements, which means it can easily be used by companies lacking resources.

Finally, the **Carbon Footprint measurement** focuses on the total amount of greenhouse gas, including carbon dioxide and methane, that are generated by a company's processes. It has a direct applicability, making it friendly to smaller companies who want to report on their environmental impact.

Thus, small scale companies who have less resources to allocate to ESG reporting can focus on targeted impact mitigation through the use of ISO certifications or the Carbon Footprint measurement. As for larger companies who have a wide area of operations and impacts, it is preferable that they choose to report using comprehensive frameworks such as GRI.

Although ESG reporting can eliminate risks of greenwashing, issues concerning objective-setting and measurement relevance need to be mitigated. As with CSR objective-setting, it's important for ESG objectives to be part of a long-term commitment. If a company meets someone else's ESG objective, that does not mean the company has an ESG strategy. Additionally, space and satellite applications entities are less likely to engage in ESG policy development. This may relate to the low number of downstream stakeholders these companies tend to have. Since stakeholders are the driving force for a company's ESG involvement, having a lower number of stakeholders can decrease the motivation to engage in sustainability strategies. For this reason, it's especially important for high level entities such as ESA to lead these companies with ESG tools distribution and clear objective-setting.

While ESG reporting provides valuable information regarding a company's sustainability level, it also presents limits which are difficult to avoid. Measurements recorded in ESG reports can often fail to provide insight into messy underlying processes, which is where important and actionable information can be found. For example, having a positive measurement for carbon impact does not mean there are not areas of improvement in the company's processes that need to be addressed. Additionally, fixating on a small part of the problem will result in burden-shifting, and might give rise to other problems. However, retrieving useful information on processes is extremely complex and time consuming, which is why it's important to conduct targeted studies on high impact systems to identify critical processes. Furthermore, it's also necessary to zoom out of processes to have a view of broader systems in order to identify the company's outputs.

An example of transparent ESG objective-setting and reporting can be found in **SES' 2022 ESG Report** [25]. They demonstrate a clear timeline of forecasted objectives completion, and cover the Environmental, Social and Governance pillars through a comprehensive report.

4.3 Life Cycle Inventory (LCI), Life Cycle Assessment (LCA) and Life Cycle Sustainability Assessment (LCSA)

Life Cycle Inventory (LCI), Life Cycle Assessment (LCA) and Life Cycle Sustainability Assessment (LCSA) are methodologies used to evaluate the environmental, social or economic impact of a product throughout its life cycle.

To conduct a comprehensive analysis and gather the necessary data for a Life Cycle Assessment, an **LCI** should be conducted first. This process involves creating an inventory of the product's input and output flows, representing the data collection component of the LCA. Input flows encompass raw resources, materials and energy categorized by type, while output flows may include emissions to air, water, and land by specific substances. This analysis can be complex, involving multiple unit processes in a supply chain, and tracking hundreds of substances.

Once the LCI has been completed, the company can proceed to conduct an **LCA**, which assesses the environmental impacts throughout the entire life cycle of a product, from production and distribution to use and end-of-life. This evaluation encompasses upstream processes such as suppliers, and downstream processes such as waste management associated with the production, use and disposal. An LCA covers all relevant inputs from the environment and emissions into space, the air, water, and soil. In the space sector, the ISO 14040 and ISO 14044 standards can be used as standardized methodologies of LCA, outlining its principles, framework, requirements, and guidelines.

The **Life Cycle Sustainability Assessment (LCSA)** framework expands beyond the traditional Environmental Life Cycle Assessment (here referred to as LCA, or E-LCA) by integrating social and economic dimensions alongside environmental

considerations. While E-LCA only focuses on quantifying environmental impacts, LCSA encompasses three pillars: Environmental (E-LCA), Social (S-LCA), and Economic (Life Cycle Costing (LCC)). This approach allows for a comprehensive evaluation of a product's sustainability performance throughout its life cycle. By considering all three dimensions, LCSA enables a more nuanced understanding of the broader impacts of space missions, thereby facilitating informed decision-making and encouraging sustainable system-level design concepts within the space industry.

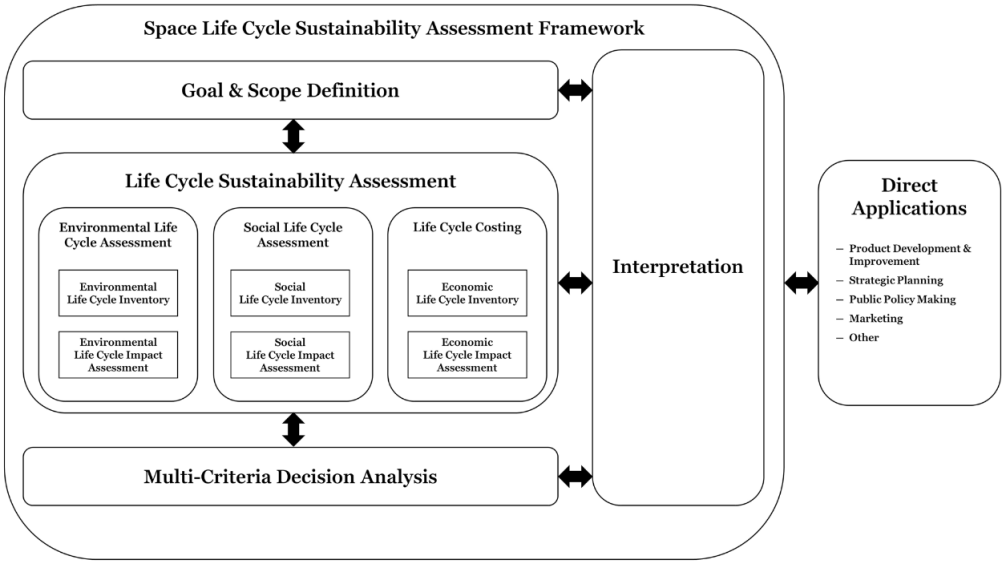

Figure 4: LCSA framework for the sustainable design of space missions [27]

4.4 Space Sustainability Rating (SSR) - How does it fit within ESG and CSR?

Space Sustainability Rating (SSR) is a rating system developed by EPFL's eSpace center and is used to determine the level of sustainability of space missions and operations. SSR evaluates missions through six criteria:

- **Mission index:** This criterion is used to track traces left in orbit by spacecrafts or satellites and to assess their impact on the space environments. It also quantifies the level of harmful physical interference caused by the planning design, mission operations, collision avoidance strategy and post-mission disposal strategy.
- **Detectability, Identification and Trackability:** Objects need to be trackable from Earth, which impacts sizing, choices of materials and coating during design. The object needs to be identifiable for registration and liability purposes.
- **Collision avoidance capabilities:** This concerns capabilities operators should have to identify, respond to, and mitigate collisions.

- **Data sharing:** Operators are rated on their sharing of space situational awareness, and the contribution of this information to spaceflight safety
- **Design and Operations Standards:** This criterion evaluates the common understanding of objectives, adoption of standardization concepts in design and operations where possible.
- **External services:** Bonus ratings for innovations taking place in close proximity operations, such as servicing and active debris removal.

When a company evaluates themselves with SSR, they are given a tier score based on their performance on the individual modules. Scores range from Bronze to Platinum and help companies who have direct impacts in space compare themselves to one another.

SSR can be made to fit as part of the Environmental pillar of a company's CSR strategy. SSR can be considered early in the materiality assessment and stakeholders' engagement to define the CSR objectives of a company, and push for the its responsibility towards sustainability in space. An example of a clear CSR objective that takes SSR's "collision avoidance capabilities" criteria into account can be: *"Our company aims to achieve a 25% reduction in satellite collisions with debris in Low Earth Orbit (LEO) by the year 2030"*. If the company studies the SSR ratings handbook and makes the application of these objectives clear from the start of their CSR strategy definition, they can then be integrated into the spacecraft or satellite's design and operations. For companies in the space sector, SSR could complement ISO 26000 guidelines or the Corporate Sustainability Reporting Directive (CSRD) [24] to add a dimension that's quantifiable for space applications. By aiming to achieve a certain rating, this could direct the company's efforts into fulfilling SSR criteria and taking them into account during the entirety of a product's life cycle.

When reporting back to stakeholders on sustainability objectives through ESG, SSR can also be integrated into the Environmental pillar. It can be combined with ESG frameworks such as GRI or ISO certifications to provide the aspect of the impact in space, which is currently not directly addressed in these reporting tools.

Ideally, SSR would be introduced early on by ESA during their campaign for instoring sustainability in their supply chain, alongside standardized reporting methods specialized in impacts on Earth, such as ISO 26000, GRI or CSRD. SSR guidelines should be available throughout the entirety of the product development, testing and operations, for high level management as well as engineers and operators.

5 Interviews

The main outcome of all three interviews are described in this section. For a complete transcription of the meetings, please refer to the Annexes 8.

5.1 Andrea Vena

The interview with Mr. Vena started with a short presentation about my literature research on ESG and CSR. Following the presentation, he commented on the European Member States' role in funding ESA, and the importance they give to ESA maintaining competitiveness in the space and sustainability sector. Mr. Vena explained that his role is to maintain a close relationship with the suppliers, and engage with them as companies with objectives, as well as on their products' sustainability.

When asked about ways to mark the importance of sustainability practices in order to **secure funding**, Mr. Vena talked about the **Code of Conduct** drafted by ESA for its supply chain. He presented the Code of Conduct to a specialized committee, who were convinced of its importance, and was given 2 years of pilot (tests) before going back to the Member States with the results. Mr. Vena observed that the situation regarding sustainability might be very different in 2 years, and that there might be a possibility of making the application of the Code of Conduct mandatory, paving the way to ESG objectives and CSR principles.

To **encourage suppliers to endorse the Code of Conduct**, Mr. Vena intends to develop incentives such as increased hourly rates and margins of profitability for companies that present satisfactory results. ESA is currently in the early stages of the development of its sustainability initiatives. There are already sustainability requirements regarding products and processes, although these have not been extended to the companies, as this will start in 2024. Mr. Vena observed that ESA has around 11'000 suppliers, ranging from big corporations such as Airbus, to small enterprises of tens of people. This makes it extremely complex to have the right support for all, and this two year period of study will provide important data for tailoring support. In the first two years of applying the Code of Conduct, suppliers will be handed a self-assessment questionnaire, and will have the opportunity to state their compliance. If they need help with compliance, ESA will develop tools to help them achieve their sustainability goals.

Regarding the **tailoring of ESG and CSR to different companies' scales**, sustainability requirements will vary depending on the business size and type. While it's impossible to have a one-size-fits-all approach, it's also difficult for ESA to have full knowledge of their suppliers' engagement on CSR objectives, making the feedback on the Code of Conduct's release crucial to assess the level of involvement of these companies.

Mr. Vena has regular **meetings with the larger corporations** in the supply chain and has opportunities to touch base on sustainability topics during the High Level Forum. Once a year, they will discuss where they are with their road map, the implementation of their objectives, and their progress regarding themselves and their suppliers. Big companies such as Airbus and Thales have as wide a supply chain as ESA, and dialogue should be held not only with experts, but with high level authority as well. Space is a small component of these companies' business,

and direct communication with the top management is not currently done. To facilitate action and efficient decision making, it's necessary to have a communication channel with upper managements, and help with concrete actions taken towards signed sustainability statements, or future agreements such as the Code of Conduct.

The two test years of the Code of Conduct will be used to open a communication channel with suppliers, and discuss sustainability topics. The agency is actively undertaking initiatives to focus on education and training. Once a year, ESA organizes Clean Space industry days, which takes place at the European Space Research and Technology Centre (ESTEC), where industries come in to discuss topics linked to clean space. In 2024, ESA will gather their suppliers and explain the purpose of the Code of Conduct, and how to embed CSR objectives and ESG reporting within their company.

5.2 Erika Wolf

The interview with Ms. Wolf started with a discussion of my midterm presentation of the project, to provide her with some insight into my thesis question. Ms. Wolf then specified the **technical meaning behind ESG and CSR**: CSR is a way for a company to measure its performance via different objectives on ESG pillars. This includes economic performance, which is important to measure the compatibility with business constraints. The first step to building objectives is to identify impacts throughout the company and its supply chain according to ESG pillars, and discuss the importance of those impacts with stakeholders, investors, and customers. Once the most important impacts have been selected with all parties, they can start building a sustainability strategy to address those impacts. Due to a lack of resources, not all ESG pillars can realistically be worked on, and efforts have to be concentrated. When looking at a large player such as Ariane, or a start-up, the level of expectations will not be the same, and will depend on if the company is developing a new product, or if they have to re-invent the way they work to address those dimensions in their daily business. Ms. Wolf specified that the space agency should not be the only actors in establishing governance over ESG topics. It's also the responsibility of the investment sector, which is notably crucial in the development of start-ups.

The **impact analysis** should be conducted by the company on the thematic of environmental impact, living and working conditions, produced waste etc. Once the **materiality assessment** has been done, the most significant impacts can then be determined with stakeholders. Not every company has to work on gender equality, social inclusion, or carbon footprint, although it ideally should be the case, in reality efforts have to be focused. This will depend on the company and its suppliers' geographical location as well, as countries come with different regulations. In Europe, an increasing number of regulations are appearing [26]. Even for small companies with more than 250 people now have an obligation to report on their non-financial performance (ESG) through a standard that is shared between different European countries, that would allow comparison between players from the same sector. What makes this work manageable is the fact that companies don't have to address all

ESG dimensions and focus on the important impacts based on their business.

The frameworks Ms. Wolf recommends the most are **ISO 26000**, which is not certifiable, and the **Corporate Sustainability Reporting Directive (CSRD)**. ISO 26000 is based on materiality analysis, which on a voluntary basis allows small companies to report on their extra financial performance, with a methodology to analyze what is material from their business perspective. ISO 26000 guidelines are the easiest framework to apply and are more simplified than the CSRD, which is mandatory when the company reaches a certain threshold. In terms of reporting and learning to build a strategy, the new apparent framework which is now enforced in Europe can be used to understand how to build an efficient strategy and how to report on it, so that the company is fully accountable and uses a common language with every player in the EU. Other frameworks can be used, but Ms. Wolf prefers concentrating efforts on one framework which will allow companies to be comparable.

A company's investors and peers will ask them to provide a certain number of **KPIs** corresponding to E, S or G. Thus, ESG reporting aims at assessing the robustness of the CSR strategy of a company. If an investment fund wants to be called an impact fund, they will need to collect a number of data on those topics. Up until now, many funds were greenwashing their communication, and claiming to work on impacts, when in reality they were not analyzing collected data. Because of this, a regulation (**Sustainable Finance Disclosure Regulation (SFDR)**) was put into place a little over 3 years ago, aiming at defining different levels of maturity in terms of impact for investment fund. Depending on where they want to be classified, they will have a certain amount of data to collect, and to demonstrate that they collected it, which will determine if they address the impacts in their investment strategy. For larger companies, the materiality assessment is much more complex due to the size of the value chain, although the methodology is the same. As for startups, they don't have their value chain yet, and the methodology may vary. However, they will have to bear in mind the pillars of the ISO 26000 and see how they can integrate the impact mitigation when choosing a new supplier, developing a new product or services. They also have to address their governance and business model. Without governance, there is no CSR strategy.

With regards to **companies working in the space sector**, the CSR building methodology remains the same as for companies in terrestrial applications. However, the environmental pillar will have to take the footprint and impact in space into account. Today, the space sector's environmental strategy revolves around arguments of helping to observe what's happening on Earth, and solutions to limit the impact of climate change on Earth. However, they have a massive impact in space, but will communicate mainly on their use of green fuel and on their products helping mitigate ecological impacts on Earth. With pollution of space debris around Earth's orbit, it's imperative to focus on these impacts for future activities.

The **motivations** Ms. Wolf presented to companies to work on their sustainability objectives regard risk mitigation on the long term. In the space sector, companies

are largely dependent on suppliers located in China/Taiwan, with whom Europe may have geopolitical issues. This might cause transportation issues in the future which may affect the product's development time. If a company works on their CSR by mapping out their risks and opportunities throughout their value chain, they may limit risks and exposure to become more resilient by selecting their suppliers not based on immediate cost reduction, but on lesser risks on the long term. The value of a company is then improved, employees will tend to stay longer, and they will have more chances of securing funding by proving their resilience.

We then discussed how **small companies could incorporate their supply chain within their CSR objectives**. Smaller companies will investigate their value chain without going in depth. They will only focus on the 1st rank of their suppliers and analyze whether there's any economic or business dependencies, the materials they use, and where they are located. Depending on the impact measured, the company will create certain objectives for their suppliers so that they can work together to improve the impacts.

Ms. Wolf recommends pushing for European initiatives, with common tools. She observed that many companies are developing their own specific tools, which makes comparison difficult. Thus, she would prefer a European initiative with a common set of frameworks and ambition.

Finally, Ms. Wolf expressed that all workers inside of a company should be kept aware of CSR objectives. People need to be involved internally to build the CSR strategy, and ideally, there would be no CSR director and each individual within a company would work together to meet defined objectives.

5.3 Alessandra Capurro

Ms. Capurro did an internship at the **European Southern Observatory (ESO)** as sustainability engineer in 2022. During her time there, she helped announce the carbon audit of the organization, by centralizing information and improving the existing model. She expressed she had difficulty gathering data scattered throughout the company, as they have bases in Munich and Chile. Ms. Capurro also worked on ESO's first LCA, of one of the instruments of the Very Large Telescope (VLT). There was a limited amount of literature on it, so she worked on finding data such as CO2 emissions and Impact 2002. In 2022, she then started working as manufacturing engineer at **Beyond Gravity**, which wasn't as directly sustainability oriented. Ms. Capurro works on the production of space mechanisms, specifically solar array mechanisms (SADM).

When she joined **Beyond Gravity**, it was announced that they were starting to have sustainability reporting, and that they would issue a CSR report in 2024. Since the company is international, they wanted to have an audit of every site, and build an environmental, social and governance overview of the company. There are currently discussions about having a Life Cycle Inventory (LCI), which is requested

by customers such as Airbus or Thales, and a possible future LCA for the products and mechanisms they are developing. Sustainability objectives come from the top of the space supply chain and flow down to lower suppliers like Beyond Gravity. Ms. Capurro sees an interest in Beyond Gravity having an impact analysis ready, but as of now, they do not have the resources and knowledge to do it. At corporate level, they are looking at ESG, and are working on a carbon assessment of the entire company. She hopes this will also be applicable to lower levels for their products.

Ms. Capurro is not currently working on applying eco design practices when working on products, but it's an objective to build towards. They mainly produce well known products, and it's difficult to integrate eco design from the start. However, there are options to implement a design through serial production or find a way to reduce the carbon footprint of each mechanism. It's important to start by conducting an LCI, then move on to an LCA to better understand the company's products' impacts.

As a manufacturing engineer, Ms. Capurro saw that the sustainability practices she wanted to integrate were too ambitious for the present level of knowledge on sustainability at Beyond Gravity. There are a lot of steps to take before developing an LCI, and multiple issues that the company faces which are driving it away from thinking sustainable. Especially in the space industry, suppliers are not held accountable for their emissions and the choice of suppliers is very restricted. This means that the company cannot require them to be more sustainable. Steps to be taken need to be very small, starting with gathering information that's already used, systems already in place instead of reinventing entirely. In the beginning, Ms. Capurro felt like they could put LCAs into place easily, but realistically, it already takes a lot of work to build an LCI.

Ms. Capurro is pushing to have an LCA in the satellite division. When she went to the Clean Space Industry Days conference from ESA, she was motivated to apply ecodesign and LCA to her work. However, she quickly realized that there were many missing steps. For example, it's very difficult to change materials or designs, or what the customers want. Thus, her first step was to gather data, understand where the information was spread within the company and figure out a robust way to do an LCI and a materiality assessment. If she works towards those first steps, this will facilitate future actions taken towards sustainable objectives.

To start gathering data for an LCI, Ms. Capurro will start investigating work packages in January 2024. It's important to be realistic with how much you need to know, and to summarize the information for it to be useful. There is no centralization of data, and it's spread out in tests and reports that need to be stored in a common place.

Finally, it's critical to maintain open communication channels with stakeholders, and discuss the granularity of the analyses that need to be conducted, as well as the amount of approximations that can be held.

6 Results

How can ESG and CSR be tailored to fit different levels of the space industry supply chain in Europe?

This question can be answered by examining the technical definitions of ESG criteria and CSR objectives, along with exploring their implementation in the high levels of the space sector supply chain, in different sized companies, and the initiation of sustainability practices from smaller suppliers.

CSR represents a set of sustainability-oriented objectives defined by a company to mitigate their impacts throughout their value chain. Through these strategies, the company can ensure that it is carried out ethically, and that it positively impacts society. CSR objectives should be clearly defined in time for comparability and should be verifiable to avoid greenwashing.

ESG is a set of criteria that are used to measure a company's overall sustainability, and helps the company meet existing and upcoming regulations coming from stakeholders, investors, and customers. It's a way to report CSR objectives to stakeholders in a standardized manner, according to the Environmental, Social and Governance pillars. Multiple frameworks already exist, such as GRI, Carbon Footprint Measurement and ISO regulations, with varying verification complexity.

The **interview with Mr. Vena** provided insight into the 2024 release of the Code of Conduct, which will impact the sustainability awareness of ESA's 11'000 suppliers, paving the way for impact analysis, objective-setting and reporting on those objectives. It's especially important for ESA to provide support and guidelines to companies who need help in starting their reporting and self-assessment, and to maintain direct communication channels with their largest suppliers' upper management (Airbus, Thales) to efficiently communicate objectives and changes.

After **discussion with Ms. Wolf**, it became apparent that a common tool should be developed by ESA or a European entity to facilitate comparability and the adoption of sustainable behavior throughout the space supply chain. Additionally, this common tool should be adaptable to small and large players alike and contain guidelines for sustainable space activities. Some examples of such guidelines are SSR, which is specifically designed for space applications, and a variation of GRI that would take environmental impact in space into account. Impact on Earth could be assessed using ISO certifications, which are easy to use for companies without significant resources to allocate to this purpose.

The **interview with Ms. Capurro** shed light on the difficulties of starting to implement sustainable analyses and practices (LCI, LCA, eco design) when working in a company that does not have preliminary preparations and knowledge in the domain. The first step to establishing a solid basis for future development of sustainable practices is to gather spread out information, extract relevant data, start

with an LCI and then move on to an LCA of the products of interest.

The depth of involvement of a company in the integration of sustainability practices depends on a its size, funds, and placement in the space sector supply chain.

Newly founded start-ups, who have not yet established their value chain in full will need to focus first on the Governance aspect of ESG, ensuring they have a solid basis for their business model, to then develop a CSR strategy. While working on their product development and establishing their processes, they can bear in mind the pillars of ISO 26000 and see how they can integrate their impacts when choosing new suppliers.

Small companies and subsystem providers such as Beyond Gravity will need to investigate their value chain and can focus on their first rank suppliers by evaluating which ones have the most impact regarding materials used or where they are geographically located. Once the critical suppliers are identified, the company can work with them on sustainable objectives aligning with their CSR strategy. Large companies like Airbus or Thales have a wide value chain, which makes their materiality assessment much more complex. These companies are expected to manage their business incorporating their entire supply chain and provide tools for their suppliers to meet their CSR objectives.

Finally, **the space agency** (ESA, NASA) has the responsibility to govern its supply chain, establish sustainability values and a roadmap for future projects and missions. Located at the top of the supply chain, the space agency should provide a flexible common set of tools, which can be adapted to terrestrial (ISO 26000, CSRD, GRI, LCSA) and space (SSR) applications. Organizing workshops and creating a direct communication channel with suppliers is also essential to having an efficient introduction of sustainable practices and having regular feedback from key suppliers.

After gathering data on ESG and CSR during my literature review, and discussing with Mr. Vena, Ms. Wolf, and Ms. Capurro, I was able to draft steps for integrating sustainability practices, including CSR and ESG, for companies of different scales who have no previous experience on the topic. The steps are detailed in figure 5.

1. **Materiality assessment, early LCSA**

   (a) **Materiality Assessment:** First, the company should identify internal and external stakeholders, assess what they want to measure, and design a materiality survey to collect insights from all parties. This will give the company an idea of which issues to focus on, whether they be economic, environmental, or social. During this part of the process, SSR guidelines can be used by the company and their stakeholders to identify the space environmental impact they might want to work on. Listed down below are common steps for conducting a materiality assessment:

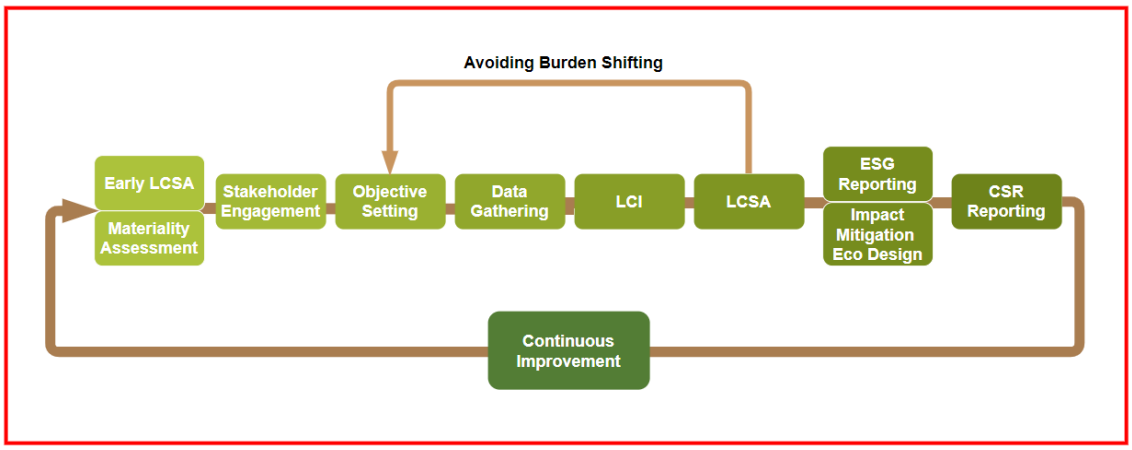

Figure 5: Workflow for integrating sustainability practices

i. **Create a steering committee:** The first step in determining material ESG issues is to put a cross-functional team of executives together to be accountable for the CSR strategy's creation and execution.

ii. **Identify specific stakeholders:** The company then needs to identify stakeholders to gain their perspective on critical issues, practices and policies. Their insights may shed light onto broader ESG-related concerns, and reporting exercises.

iii. **Compile a list of material issues:** Working with stakeholders, the steering committee can consult cross-issue frameworks (GRI, SSR) and conduct a bench-marking exercise, which measures the organization's products, services, to establish targets, priorities and improvements.

iv. **Meet with individual stakeholders:** Gaining feedback from stakeholders through surveys, one-on-interviews and sessions with interest groups. Discussing common goals may facilitate effective communication to internal and external stakeholders.

v. **Analyze material issues and create strategy:** Finally, the company can analyze results gathered and create a plan to execute.

(b) **Early LCSA:** LCSA [27] corresponds to a combination of Environmental LCA, Social LCA and Life Cycle Costing. Performing an LCSA early on in the process will give all parties a better understanding of the company's notable impacts.

- **ISO 14040** guidelines and requirements [21] can be used for the LCSA's Environmental Management.
- Social LCA can be carried out based on the **UNEP-SETAC** "Guidelines for Social Life Cycle Assessment of Products" [22].
- The European Commission has developed a series of sector specific **Life Cycle Costing calculation tools** [23],d which can be adapted

to products within the space sector. This tool considers all costs that will be included during the product or service's lifetime, including purchase price, operating costs and end-of-life costs.

2. **Stakeholder Engagement:** The company should then discuss the importance of impacts, and the granularity objective with stakeholders. This will also shed light on the number of approximations that can be used when conducting analyses. The ESG reporting framework to be used should be clear to all parties.

3. **Objective-Setting:** Once the impacts to work on have been selected, the company's management should establish and communicate CSR objectives to everyone working on a project. This includes engineers, operators, quality control and marketing.

4. **Data Gathering:** After CSR objectives have been set, project contributors can gather KPIs on products and processes' impacts. Depending on the company's size they will also need to assess their suppliers' impacts and compliance to CSR objectives.

5. **Life Cycle Inventory:** Once relevant KPIs have been collected, engineers analyze the products in more detail, by quantifying all natural resources consumed and all substances emitted into the environment by the life cycle system. The ISO 14040 guidelines [21] describe how to correctly conduct an LCI.

6. **Life Cycle Sustainability Assessment on products:** With the necessary data gathered during the LCI, engineers can then perform an LCSA of the products, and measure their environmental, social and governance impacts through every phase of their life. If the company decides to use SSR, the LCSAs' results will help in determining if they are compliant with SSR criteria (mission index). It may be beneficial to iterate back to the definition of CSR objectives after performing the LCSA: A company who has been newly introduced to choosing impacts and using LCSA may select familiar impacts such as carbon emissions or greenhouse gas emissions, without assessing other impacts. This may result in burden shifting and can be prevented once a comprehensive analysis has been done through LCSA.

7. **Impact Mitigation, Eco Design:** Once all impacts have been measured, actions need to be taken to address CSR objectives. This may imply changes in design, working on objectives with suppliers, or implementing eco design practices.

8. **ESG Reporting:** The company will report the KPIs on E, S and G pillars back to stakeholders through the selected framework. ISO guidelines [20], SSR [4] or GRI [17] can be used for ESG reporting in space.

9. **CSR Reporting:** CSR reporting is initially done within the company through the application of SSR, ISO guidelines or CSRD [24], to keep everyone informed of progress. The CSR officer and high level management should also issue a yearly CSR report to keep customers and the public informed.

10. **Continuous Improvement:** Once the impacts have been reported, companies should strive for continued improvement by analyzing KPIs to ensure there is no burden shifting, meeting with stakeholders to redefine objectives if necessary, and monitor effectiveness.

7 Conclusion

2024 marks a year of change and integration of sustainability practices at ESA, through the release of the Code of Conduct as well as tools and guidelines for companies affiliated with the space agency to assess their impacts. These sustainable practices are now trickling down the supply chain, and smaller companies such as Beyond Gravity are starting to implement CSR objectives and looking to perform LCIs and LCAs. As strategies are being put into place, it has become crucial to keep a standardized set of tools to increase comparability throughout the supply chain, and to involve all members of companies' inner hierarchy in the application of sustainable practices and sustainability training. Such frameworks and practices must be chosen to be adaptable for companies of different scales and sectors. As such, SSR, LCA and ISO certifications have been proven to be easily applicable to a wide range of enterprises.

Frameworks such as GRI, SSR, LCA, and ISO certifications emerge as adaptable tools, catering to companies of varying scales and sectors. This allows them to transparently communicate their impacts, refine CSR strategies, and demonstrate progress to stakeholders. Through a shared commitment to responsible practices via CSR and ESG, the combined efforts of private and public space enterprises secure the well-being of both Earth and space, as they advance in technological prowess and explore further into the universe.

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8 Annexes

8.1 Re-transcription of interview with Mr. Andrea Vena

Andrea Vena: Engaging with suppliers is extremely complex, the governance of ESA lies towards its member states. One of the great successes of ESA is that member states are funding ESA (we don't only want to progress with our scientific knowledge of our planet or the beauty of space, but also so that we can withstand the competitiveness). The funding from the member states is transferred by ESA to its industrial chain. The member states are very sensitive to any type of undertaking the agency has, there is a lot of attention drawn to it. One of my key objectives it to engage with the suppliers on two levels: engage with them as companies (code of conduct, CSR, engagement), and engage with them on the product (what they will provide, the way they contribute to an ESA project should also be sustainable). You are not buying satellites off the shelf, a company will have to design with specific requirements. This can be done in a socially responsible way.

Gloria Mellinand: Regarding the member states, you said it was very complex to manage the funding you receive. Is there a way to mark the importance of the establishment of these policies, and how there should maybe be an increase in funding regarding CSR and ESG?

Andrea Vena: Absolutely, we will start with the code of conduct, a large consultation among the states to convince them that this code of conduct is the very first step we have to take to responsibilize our suppliers. It's a complex exercise, we went through a number of consultations with a specific committee, at the end of the day they were convinced, but need to have 2 years of pilot (test) to see how effective it is. We are going to apply the code of conduct generally next year (2024). The companies will have to evaluate themselves if they want, on the basis of the principles of the code of conduct, and get back to us to tell us if they are qualified, and if they need help in some areas. At the 2 years of pilot, we shall go back to the member states and tell them the situation. I'm sure everything will be much different from today, and eventually we want this code of conduct to be mandatory, and pave the way to CSR principles and ESG objectives. This is what we have been doing with the funding. We should also think about how to be more competitive. Member states support ESA because ESA supports innovation, R&D, and support the competitiveness of the industry. What we are doing with member states is convincing them that innovation can be put at the service of CSR, and particularly the protection of the environment. We are putting them on the leading edge on those topics. About funding: We are not going to give them direct funding, but we are evaluating the possibility to have some incentives. If the company could demonstrate they have done concrete actions and investments to improve their CSR and ESG, we may give them some incentives such as margins of profitability which would be higher, or their hourly rate could be increased for the investment they have done.

Gloria Mellinand: Have you seen a significant involvement of those companies

with regard to those incentives, what is the ratio of companies that have accepted to willingly do this?

Andrea Vena: We are the very early stages of this process. We already have requirements for the processes of the products, but we are not yet there for the requirements regarding companies. Companies start from next year (2024), and we will see what the reactions will be. We have some 11 000 suppliers, they range from big corporations like Airbus, to small enterprises of few tens of people who are working on a specific technology. It's complex, we have to give the right support to everybody.

Gloria Mellinand: Thank you, I will be starting with my questions. The first one concerns how you keep track of the ESG and CSR within the industry chain. Could you share some insight into how ESA communicates its ESG and CSR objectives and how they track the compliance at different levels of the industrial chain, or how you plan to do it?

Andrea Vena: This is actually the business of the code of conduct, when we are going to deploy it next year, together with the self assessment questionnaire, all the companies that are making business with ESA will be invited to compile these self assessments. They need to measure their compliance with the code of conduct, and then come back to us with their check list. We want to help them to become compliant. The contractors and the sub-contractors should all be compliant.

Gloria Mellinand: What kind of support were you talking about when you said that they needed some help to comply to the code of conduct? It is a very wide network that is surrounding ESA, and it seems difficult to do so.

Andrea Vena: For the moment we are focusing on training and supporting the availability of tools (CSR, materiality matrix tools).

Gloria Mellinand: What are these tools, what kind of method of reporting do you think you're going to help to put into place?

Andrea Vena: We have not yet decided what kind of standard or method of tool to use because so far, we are using a type of report based on GRI, but we are not really sticking to any technical standard. We are going to select a standard to apply, and the one that we apply to ourselves will be the same that we recommend to our suppliers.

Gloria Mellinand: I saw the RTS that you developed, and thought this was the standard that you were going to apply. Was this not the case?

Andrea Vena: I'm pretty sure that it's very much the case, but not in full, I'm not sure we are totally compliant with the standard. If you need to know more about that I can put you in contact with a colleague of mine (Ms. Marion Mirailles,

CSR Officer) who will be able to answer those questions.

Gloria Mellinand: That would be very much appreciated, thank you. This is more concerning the tailoring of ESG and CSR to different scales of companies. You said there was going to be the same tools that would be distributed to everyone, there might not be tailoring if a company has a lot of resources compared to another one with less funding?

Andrea Vena: For sure, in terms of requirements, they will be very much dependent on the type of company we will be working with. There is no way to have a single approach. The size of the companies is important to consider, both the type of business and size. We will start with very basic requirements, and again with the code of conduct, the companies will tell us where they are compliant, how... We do not know all the companies, we perform regular audits on the companies that are working with us, and there is a consideration to include also some CSR aspects in the audit that we do to check if the claim of the company is a real one. It's a matter of knowledge, and so far we have little knowledge on what they engage on, and we need to acquire it for a tailored approach. For sure we can have a one size fits all approach, but it's not possible to personalize with 11'000 suppliers.

Gloria Mellinand: It could be of use to have the major companies such as Airbus, who would be responsible for all of their supply chain, and this would greatly reduce the responsibility that you have at ESA to keep track of everyone, and have those intermediaries that would have the voice of their entire supply chain, and then you would organize some regular meetings with them regarding these objectives.

Andrea Vena: With the large corporations, we had regular meetings a couple of times, but there is also a big event that takes place every year with all of them (high level forum), we have several opportunities to touch base on sustainability topics. Once a year, we will ask them where they are with their road map, where they are with the implementation of their objectives, and their progress, for themselves and their suppliers. With big companies such as Airbus of Thales, who are as wide as ESA in terms of supply chain, we have been in a dialogue for now 3 years, continuously. We dialog with experts, but we also need to do this with high level authority.

Gloria Mellinand: This next one is about the communication, since it is a matter of influencing people and giving them incentives, what are the main communication issues you have faced when talking to those companies to put them on the same page?

Andrea Vena: We did not encounter specific issues. The problem with large companies is that there is a connection between the experts who are every well aware of the sustainability issues we are talking about, and the top management, who oversee a much larger group. Space is only a little component of their business. Thales are focused on many other things, and there may be a gap with us that we want to fill. Communicating with the executive part of companies is equally

important to communicating with the experts of those companies. This is what we need to push forward more than what we are doing today. My daily work is with the experts of those companies. We have to touch base on a CEO level.

Gloria Mellinand: Yes, this would mainly be to facilitate any changes or to have open communication regarding ESA's objectives. The decision level should be on the executive's part.

Andrea Vena: We have been promoting a statement for a responsible space sector, which is a declaration that has been adopted by almost 40 private and public organisations mostly in Europe. This statement is aligned with a number of values, principles and objectives. The statement that has been signed is very high level in those companies (Airbus, Thales, all signed). This is a statement that should be filled with concrete actions, we are having working groups but again these working groups are at a working level. The needs to be this dialogue with the top of the companies to fill the gap, and have these engagements on a company level.

Gloria Mellinand: In regards to facilitating communication, are there any open channels for transparent communication with your industrial partners, for example facilitating whistle blowing or talking about issues openly?

Andrea Vena: This is something we are planning to have in the future once the code of conduct is in place. We are using these 2 years to gather lessons to hear from our suppliers from topics that they are struggling with. There should be a way to have an open channel with them on those topics, but this requires this period of trial that we will start in 2024.

Gloria Mellinand: With regards to education, there are tools that ESA thinks of putting at use for suppliers, do you think of maybe having some workshops where you will invite big companies, or maybe smaller ones to have this awareness of CSR and ESG principles, and have this education that is quite essential? If people realize the importance of those tools maybe it will be easier to implement them.

Andrea Vena: As far as the Environmental part of ESG is concerned, we are very much engaging in education, training. Once a year, the agency is organizing the so called Clean Space industry days, which are a number of days in our big part in ESTEC where industries come in to discuss topics that are linked to clean space on both sides. There are discussions about designing eco friendly systems, and ESA is the only space agency in the world that has this type of guidelines for helping our industries apply rigorously LCA for space systems. In 2024, we will gather our suppliers and explain to them what is the code of conduct, and give them a very large view of what CSR is and how they could embed ESG objectives in their company.

8.2 Re-transcription of interview with Ms. Erika Wolf

Erika Wolf: I have some inputs that are quite important. When we talk about CSR, it's not about initiatives addressing the different ESG dimensions, it's really the fact that you integrate objectives regarding those dimensions. So when we talk about CSR it's basically when the company decides to measure its performance via different objectives on different ESG pillars. It doesn't mean the company will forget about the economic performance, you still have the performance part of the CSR strategy which is quite important if you want it to be compatible with business constraints. And also when you build this strategy, first identify your impact (if you speak to a space company with manufacturing engines, you first need to measure you environmental, social, and governance impacts throughout your supply chain, you need to discuss and validate the importance of the impacts with your stakeholders, investors, space agency and customers, and then when you have full visibility on your impact you can build a sustainability strategy which can address the impacts. It's a question of methodology but looking at what you just said [the introductory presentation] you can have the impression that you just need to work on all the ESG pillars, which is not exactly the case. You need to work on your impact, identify with your stakeholders and then you develop a strategy. It's quite important, otherwise you might think that all the companies will have to do the same thing. Typically if you speak to a start-up and a large player like Ariane, the level of expectations will not be the same and it really depends on if you build something new, or if you re-invent the way you have worked until now because you have address those dimensions in your daily business. The starting point is measuring the impact to report on your progress. When you say that the space agency should establish governance to allow the sector to accelerate on the ESG topics, it's not only the space agency. Of course they have a key role to play and without them it would not be achievable, but you can count also on the investment sector. Today, when you look at start-ups, we need to respond with investment funds in Europe, they start to look at ESG dimensions and they start to impose some ESG objectives on the start ups they finance.

Gloria Mellinand: What tools do you use to measure the impact of a company, before making the assessment?

Erika Wolf: You analyze the value chain, according to what you buy, where and from who you buy, you will say I have impact on climate, on living conditions or working conditions, produce waste etc. So you will detail all the impact that you produce throughout your value chain, and then you will determine if it's material or not. It's something you usually do with your stakeholders. I want you to keep that in mind, otherwise we have the impression that CSR means that each and every company has to work on gender equality, social inclusion, carbon footprint etc. Ideally, in the best world ever, yes it should be the case. But concretely, a company needs to focus first on its impact. And again, an operating player in the space sector doesn't have the same impact as an engine manufacturer in terms of environmental footprint.

Gloria Mellinand: But shouldn't the social and governance aspect be taken into account in any company in any company that has workers?

Erika Wolf: Yes but typically depending on the place where you have those workers, either in China or in Europe, the level of objective will not be the same, and it's not the same if you work with suppliers in Europe or in Asia or the US. What I'm saying is when you build a CSR strategy, you don't have to tick all the boxes. You need to adapt it to your value chain and to the expectations of your customers, and expectations of the space agency, and you need to work on that based on the actual impact of the company through the value chain, whether you use renewable energy, you use a lot of young people from universities... Based on that you can build your strategy.

Gloria Mellinand: Yes, and with different countries come different regulations that imposed by the countries.

Erika Wolf: Yes. And on top of that, just for you to know, there is an increasing number of regulations throughout Europe, even for small companies with more than 250 people, who have now, starting from January, an obligation to report on their non financial performance (ESG performance) to report through a standard that is shared between the different European countries, and that would allow comparison between players from the same sector, and typically they have to report only on what is material with regard to the impact throughout the value chain. It does address even smaller companies, and it's a lot of work for companies but it's still manageable because they don't say I will address all the ESG dimensions, I will focus on what's important based on my business.

Gloria Mellinand: Okay, is this the materiality matrix?

Erika Wolf: Yes, you have the simple one and the double one. I can expand on that but maybe that's not the main objective of your study.

Gloria Mellinand: Yes, but it's very interesting to learn about it. Maybe I can start with my questions and we can discuss more about it afterwards. What frameworks do you recommend small companies implement for their ESG and CSR objectives?

Erika Wolf: The most famous one is ISO 26000, which is not certifiable. However, as I said there's an increasing number of regulations and the one that I mentioned regarding the non financial reporting (CSRD), they have just initiated a format of reporting, based on the materiality analysis, which on a voluntary basis allows small companies to report on their extra financial performance, with a methodology to analyze what is material from their business perspective. This is much more simplified than the CSRD which is mandatory when you reach a certain threshold but it's very accessible. When I started working on CSR, I was so impressed by the number of standards and labels, and the easiest one for sure is

the ISO 26000. Of course you can use the SDGs, but the ISO 26000 give you the fundamentals of what you have to do when you want to develop an efficient CSR strategy, but it's only guidelines. But in terms of reporting, and in terms of how to build a strategy, the new apparent framework which is now enforced in Europe can be used to understand how to build your strategy and how to report on it, so that you are fully accountable, and with a common language with every player in EU. Of course there are others that can be used, but I do prefer using the one which will allow companies to be compared to others.

Gloria Mellinand: All right. Could you tell me about ESG frameworks?

Erika Wolf: ESG is just a way to measure CSR performance. ESG is the data that will be collected by your peers and investors, who will ask you to provide certain KPIs corresponding to E, S or G. So ESG aims at assessing the robustness of the CSR strategy of a company. If you speak to investors, they will tell you they are subject to regulations in EU which obliges them to collect a certain number of ESG data. Depending on whether the investment fund want to be called an impact fund, they will have an increasing number of data to collect on those topics. Up until now, there were many funds who were saying "I'm green, I do work on impact and I collect ESG data". In reality, they will collect data, but not analyze them. Because of all this greenwashing communication, there's been a regulation that has been put into place a little over 3 years ago (SFDR) which aims at defining different levels of maturity in term of impact for investment fund. So basically you have 3 types of funds, the art. 6, 8 and 9 under the SFRD. Depending on where you want to be classified, you have a certain number of data to collect, and to demonstrate that you collect, which will determine if you address more or less impacts in your investment strategy. So ESG is more and more regulated, it will not force you to act, it's just a constraint that is put on people to collect data. For larger companies, the materiality assessment is going to be much more complex, but for me the methodology is exactly the same, we will have to adapt to the complexity of the value chain. When you are a start-up, you don't have your value chain yet, the methodology may vary a bit, because if the startup wants to be responsible, then they have to bear in mind the different pillars of the ISO 26000, and start to see how can they integrate the impact when choosing a new supplier, developing a new product or services. The key point is also to address the governance and the business model, if you don't have the governance, then there is no CSR strategy. But is your thesis more focused on ESG or CSR, because ESG is more for investing companies?

Gloria Mellinand: My thesis question concerns both of these, because I'm looking at the objectives, but also at the way to assess them.

Erika Wolf: As a matter of clarification, you need to have KPIs for each and every objective that you set in your strategy. When you build your CSR strategy (for example reducing the carbon footprint) and you have KPIs to monitor your carbon impact, and you will have KPIs for each and every impact that you have internally. Then this data will be recollected as ESG data by the investing company.

Gloria Mellinand: Thank you for the clarification. So my next question is regarding space applications. Is there a difference you have encountered with the application of CSR in space compared to terrestrial applications?

Erika Wolf: The methodology to build your CSR is the same. Then, if you look at the impacts of a space actor compared to a consulting company, it will not be the same. The specificity of space is that you have deal with the footprint and the impacts on Earth and in space. Today, the space sector claims that they are helping to look at what's happening on Earth, and we are useful, and that they provide solutions to limit the impact of climate change on Earth, but they have a huge impact in space, but they will communicate mainly on the fact that their products save the world and they do use green fuel etc. The topic would be a bit different, but if you look at what a space company does, it starts with "How do I measure my impact based on what I do as a product or a service." The thing with the space sector is not only what they do today, but what they expect to do in the next decade, which has a lot of positive impacts for Earth, but as you may have seen in the last UN reports issued at the end of October, we are about to reach a tipping point in space activities and the fact that there's traffic in space. For the UN, we are at a tipping point because of potential collisions in space and non control of this traffic in space.

Gloria Mellinand: Regarding the incentives that you present to the companies to work on their CSR objectives, what kind of incentives are there?

Erika Wolf: I do not use the word incentive, but usually I will tell them that it's like you act like a "bon père de famille", and that you will better monitor/mitigate your risks in your supply chain. In the space sector, we are largely dependent from certain suppliers which are in China/Taiwan with whom we may have some geopolitical issues, and they may not send out certain electrical components or solar cells that you need for your satellite, if you work on your CSR properly you will map your risks and opportunities throughout your value chain, so the opportunity for the company is to limit risk and exposure to be more resilient in case of trouble in the transport conditions. Typically in the canal of Panama, in case of low water conditions, you could not transport items between Asia and Europe, you need to anticipate that. If you do that through your CSR strategy, you improve your resilience and ensure your business for longer than 3 years from now because you have chosen the cheapest supplier at the other part of the world that is less reliable. The value of your company is then improved because you manage your risks better, because you have people who stay, because you address societal and planet issues so it's another main driver for a company to do that. They are not incentives, but business arguments that you give to manage companies, saying "If you do not do that, you may lose access to certain markets because now even in the public sector in Europe you have to meet certain ESG criteria, you may lose access to certain funds because investment funds look at those criteria and they will value your company more if you work on your resilience or level of risks in your value chain, and it also

influences people internally, and you keep the good people at the right place, and they don't move after 2 years because they feel like the company seriously addresses these topics."

Gloria Mellinand: How do you guide companies who have their supply chain with the CSR objectives, how different is it in terms of assessment when they have suppliers from different regions and backgrounds?

Erika Wolf: For small companies, they will investigate their value chain but they will not go very deep, they will only have the 1st rank of suppliers, and they will focus first on the most strategic one, whether there's any economic dependencies or business dependencies, what are the materials that they use, where they are located, and depending on that and the impact that you will have measured, you will fill certain criteria objectives for the suppliers so that they can work with you to improve the impact. So you will first map the key suppliers to understand where you have risks, then depending on their impact and where they are located you will have a discussion with them about their practices on the pillars which are going to interest you in terms of environmental and social impact, and then in the second step you will try to set objectives for them so that they can act in a responsible way. Now we expect companies to manage their business incorporating the supply chain, there are additional regulations that I will not mention today.

Gloria Mellinand: How do you recommend that employees engage in sustainability practices?

Erika Wolf: I would definitely push for European initiatives, a strong one that is not from KNES, the one from ESA, the one for the startup or the large player, which does not only address a matter of footprint on Earth, but also we need to work on common tools. I know that EPFL is working on LCA tools for other sectors. Everyone is doing their own stuff and I would definitely prefer a European initiative with the same tools, same rhythm and same ambition.

Emmanuelle David: Why shouldn't it be ESA leading this effort?

Erika Wolf: I don't know who should be leading this effort, I'm just saying that I have the impression that you have many players, and sometimes I have the impression that what they claim, they do things in parallel which seem like more or less the same thing. I would have less initiatives but with all the players not duplicating this exercise. But maybe I'm wrong, this is just my impression.

Gloria Mellinand: Do you think employees should be kept in the loop of those objectives so they can learn more about sustainability in the design for example?

Erika Wolf: This is a confition to success. You should push so that everyone is aligned on the need to develop business differently, you have many gains that are very well known now, and you need to raise awareness on the need to act differently,

and you also need to involve people internally to build the CSR strategy. I use the impact analysis in every company that I work with to align people internally on the impact of their work in their own perimeter. It's not the business of a CSR director, it's part of each individual within a company. In my ideal world, I would hope that there would no longer be any CSR, or impact director, it's the business of everyone in the company.

8.3 Re-transcription of interview with Ms. Alessandra Capurro

Gloria Mellinand: Could you talk a little bit about your work you're currently engaging in as manufacturing engineer and also your past work as sustainability engineer at the European Southern Observatory?

Alessandra Capurro: At ESO, I was really focused on environmental engineering. I had 2 main tasks, the first was to help announce the carbon audit of the organization. They had done it through a consulting company for 2019 and I helped them develop it for 2020 and 2021. So pretty much like gathering data and improving the model that they had for the whole organization. They are international, and the have bases in Munich and in Chile, so they have multiple locations that they have to monitor. And so it was a big struggle, let's say for them to gather the data in one place, and it's something I'm seeing right now also in Beyond Gravity, having those data available. It's tough, sometimes having the information and then do one LCI, it's the hardest step when you have to invest a lot of time just researching data. And so that was one of the things I did, the other one was an LCA of one of the instruments of the VLT, the very large telescope. They have the biggest telescope they have for now, so we picked one instrument that had enough history that we could see we could do an LCA of its whole life cycle and assume what was going to happen at the end of life. We had a lot of data on it, and the user interface, so it was interesting because it was the first time that they had this view on one of their instruments. They never had done an LCA on any of their products before. Also maybe with the amount of papers or observation that you actually do with the telescope and try to relate it to something, it's very interesting. There was not much literature on it so we were trying to figure out how to find data like the CO2 emissions. During the LCA, we didn't only look at the CO2 emissions but also other indicators such as Impact 2002 (?) which brings down the impact into four main categories. That's what I did at ESO, and then now at Beyond Gravity it's more manufacturing engineering work. I don't work in sustainability actively, not yet at least. When I joined last year, it was being announced that they were going to start having sustainability reporting and that they would have a sustainability report for 2024. So for this year, I'm looking forward to see what its going to be. It's high level they're working on at corporate levels. Since the company is international, they wanted to have an audit of every site, not only environmental but an overview of the social and governance initiatives. I work on the production of space mechanisms which are mainly SADM, so solar array mechanisms, and I'm trying to bring a little bit of sustainability here too. We're in discussion of maybe having some LCI and possible future LCA for the products for the mechanisms we are developing, and one of the the things we've also been requested from our customers is to provide some LCI for our products. Thales is asking for this and Airbus as well, so this is something that is coming out as well. I know it comes from the top and it flows down, and it's getting to us despite being a lower supplier. I think there is a real need and that's arriving to us as a manufacturing company, I see the interest from Beyond Gravity to have something ready, because right now we don't

have the resources and knowledge to do it. Someone has to start this and hopefully it's going to be done. At corporate level they are looking at ESG, it's included that they're having a carbon assessment of the company in general, and hopefully also at a lower level for our products. I know that they are working on assessing carbon impact and then working on renewable energies.

Gloria Mellinand: As manufacturing engineer, do you know of any eco design practices that you are working with?

Alessandra Capurro: Right now I'm not, I wouldn't say that we have anything in place for eco design but it's the objective. What we mainly produce are more well known products, it's hard to integrate it in the design from the start, but I can see options to implement a design through a serial production, or even a product that has been produced more often, find a way to reduce the carbon footprint of each mechanism. We don't have an idea of how much we impact our products yet and I think we have to start with having an LCI and understanding of our information to then move on to LCA. It's a bit early for the company I think, but I'm pushing for it.

Gloria Mellinand: About the CSR and ESG, you talk about that for Beyond Gravity, but could you talk about the establishment of these at ESO?

Alessandra Capurro: It was just starting when I joined, I'm always arriving when the company starts to do something, and they were looking to have a CSR report. I know they hired a CSR officer when I left after for my Master's thesis. At first, it was a side task for the scientists, but I think it became bigger in their organization. I don't know if they released a report, I don't remember seeing one but they were aiming for it.

Gloria Mellinand: Could you talk about your personal motivations for working in sustainability?

Alessandra Capurro: I believe that climate change is the biggest issue we have ever faced, and the consequences are really harsh. With my work, I want to contribute to help solve this or get closer to a solution so that we can live in a more sustainable way. I believe that we should all apply this in whatever field we are, because in the end we are all impacting the environment, and space is a part of it too. We need to start asking those questions, and push to have those prioritized as well, because I feel like it's hard, especially in manufacturing companies where I'm now to have sustainability as a priority when usually you base everything on how much you sell rather than if you're sustainable in it. I think if I can make a contribution, that's the biggest impact I can have in terms of fighting climate change.

Gloria Mellinand: For the evolution of your approach to these sustainability practices between your job as sustainability engineer and now as manufacturing engineer, how has your past experience shaped the evolution of your approach to these sustainability practices in the manufacturing setting?

Alessandra Capurro: Now, as manufacturing engineer especially, I see that maybe what I wish to do is a bit too far, and not achievable yet for the industry. There's a lot of steps in between, a lot of problems that the company faces which are driving it away from thinking sustainable, even supply chain issues that you were mentioning, the fact that suppliers are not held accountable for their emissions and in the space industry, it feels like our supply chain is very restricted and you don't have much of a choice of who your suppliers are, so you can't come in and require them to be more sustainable. The steps need to be very small, gather information that are already used, systems that are already in place instead of reinventing completely. In the beginning, I felt like we could put LCAs into place and do things easily, but then I saw that we need to have a lot of small steps first, make it realistic and have an LCI first.

Gloria Mellinand: Do you have any examples of how you're trying to implement this and what difficulties you have faced?

Alessandra Capurro: For example, I'm trying to push to have an LCA in our satellite division, which is different from the ESG reporting that I was telling you about, which is more corporate level. I was interested when I went to the Clean Space Industry Days conference from ESA, and had a lot of motivation to do eco design and LCA. Then when I came back I started thinking about it, and saw there were just so many steps missing in the middle. To get there, I can't assume that we're going to have the possibility to change material so easily or to change designs, or what customers want easily. There are a lot of blocks, and so I thought "Okay, let's start slowly. Just gather the data and understand where all the information is spread in the company. Let's figure out a robust way to do an LCI, once we have this we can move forward to the next step." Let's say trying to do the big work now to reduce the effort later, also go in small steps. We can start with the basics like the assessment of materiality. I want for the tools to be ready in the company so that this can be done easily within the company without having to do extra efforts. It's also important to make people understand that it's something useful to do and not just a rule. It doesn't come immediately.

Gloria Mellinand: You're doing it from inside the company, but there should also be something like this coming from outside the company. Stakeholders or ESA that could provide those tools and make the process more guided.

Alessandra Capurro: Yes, very much. I received from Thales an Excel to perform an LCI, you have to fill it in and they give you a guide on understanding the Excel. It's enormous and very realistic, the kind of information they want we'll never manage to get them. I think trying to bring everyone online on what we can actually achieve, and help them understand how much we consume and what we can reduce is a big part of it.

Gloria Mellinand: Apart from ESA, are there any other stakeholders at Be-

yond Gravity who are requiring this more?

Alessandra Capurro: Yes, Thales is one for sure, we work with Airbus as well, so these are going to flow from them as well. I know that they work on it. What we would need to do to make our customers happy is just to have an LCI ready which is still a lot. We're not there yet.

Gloria Mellinand: I can imagine it must be difficult to assess so much information and so many processes for your satellites alone, and isolate the useful information. Do you have any efficient storage for the entire company so that everyone can assess this kind of information?

Alessandra Capurro: That's a good question, and it's exactly what I would like to investigate in the work package I should start in January. The idea is to understand where the information is spread, because we have tons of information everywhere. You should be able to get back to this information, but you have to be realistic on how much you actually want to know, it's a lot to asses. It's important to be able to summarize the information, but I'm pretty sure we have it. In the space sector, we need to trace back everything you do, so I'm sure it's somewhere, but probably spread out in all the tests and reports. For example, regarding the human impact, you have to look at how many people worked on a project, for how many hours, what's the impact of everyone around working on the mechanism, the materials and energy consumed? I think that's going to be challenging.

Gloria Mellinand: So you mean the physical human impact?

Alessandra Capurro: So for example when I did the LCA for ESO on the telescope, when we consider the physical aspect, it regards the amount of mass of a specific material that we used, what does that correspond in emissions and how much you need to produce the material. We also need to take into account the tests to do this, other verification and so on. There's also the FTE impact: if I work on a project for an hour, what's my environmental impact? That depends on the facility where you're working in, in which country are you, and are you using a laptop? Are you in a clean room?

Gloria Mellinand: That all seems very difficult to trace. How would you do it?

Alessandra Capurro: Well, you have to book your hours and they are registered, I presume managers have an overview of how many hours an engineer worked on a project. So you can trace it back, and it can be feasible. I think all the information is somewhere, it's just a matter of finding it, since everything is so spread out and not designed for an LCI. The biggest effort we'll have to do is to dig into it, and that's the biggest effort of a lot of manufacturing or production company.

Gloria Mellinand: About the importance of communication channels with ESA or stakeholders, everyone needs to be on the same page about a certain objec-

tive, if you need help with something. That's a very critical and ambitious project that needs to be done.

Alessandra Capurro: Yes, exactly. It's a discussion to have with our customers to understand the granularity of what our analysis should be, the amount of approximations we can have.