Advancing Space Sustainability: Initiatives from Academia and Industry

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BEREC external workshop on the environmental footprint of satellite constellations

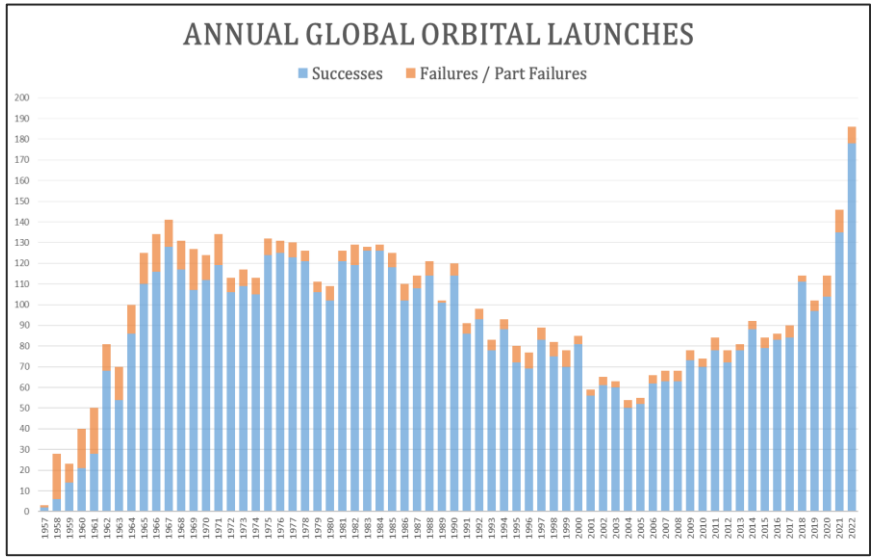
GCU Glasgow Caledonian University

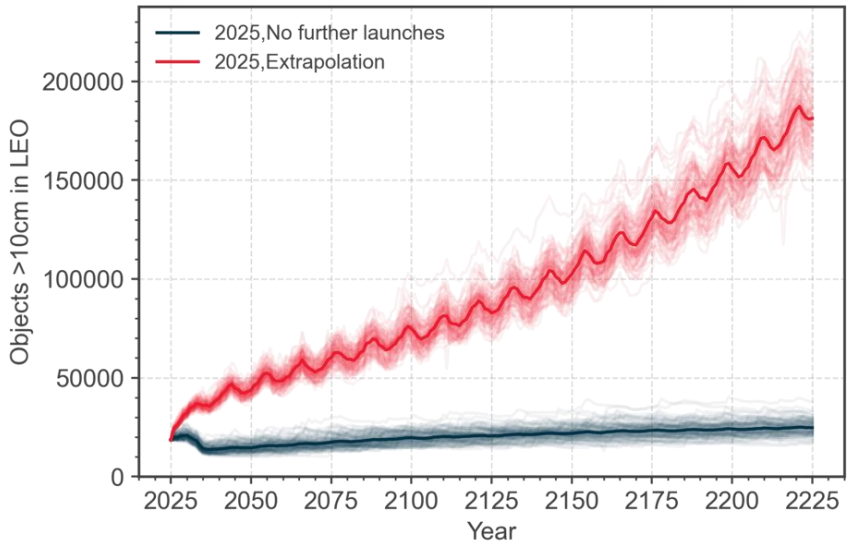
Why space sustainability matters?

- The space sector is currently going through a significant transition from a government-led domain to a dynamic, private sector-driven industry with increasing investment, innovation and new commercial markets.

- In addition to an expansion of economic activities and employment, this growth has sharply increased our ability to address societal challenges through space data.

- However, it has also heightened:
  - The space debris population
  - Orbital congestion
  - Light pollution
  - The environmental footprint of the sector

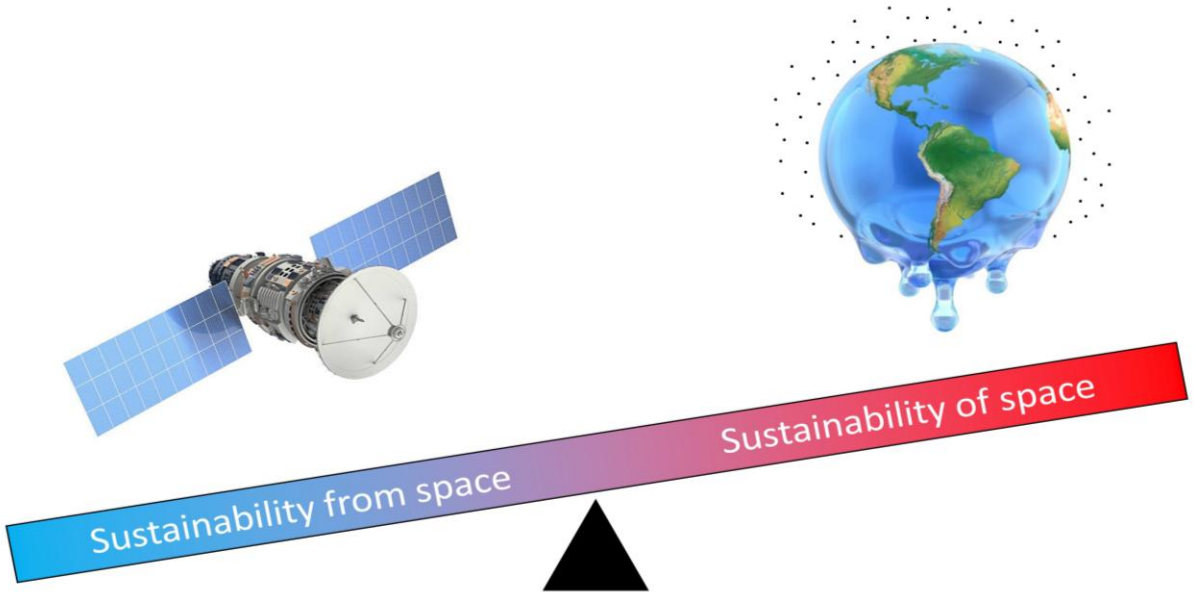


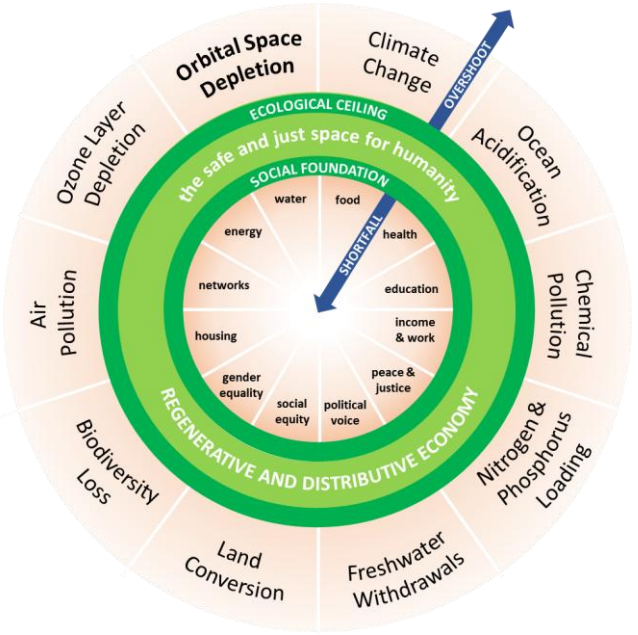


‘The Space Sustainability Paradox’

This tension might lead to a paradoxical situation whereby the use of space to support sustainable development becomes unsustainable from the perspective of both the Earth and space environment. This situation can be described as the ‘space sustainability paradox’.

To avoid falling victim to this paradox, it is imperative that we consider the interrelated nature of space sustainability policies and initiatives.





A.R. Wilson & M. Vasile, “The space sustainability paradox,” Journal of Cleaner Production, Volume 423, 15 October 2023, 138869.

Presentation outline

Address the space sustainability paradox has been central to my work across the two organisation I work for:

Metasat UK Ltd

A Glasgow-based 'Clean Space' start-up founded in December 2020 in response to the growing interest in space sustainability. The company is an R&D and space sustainability consultancy company, offering services on space LCA, eco-design and carbon accounting, whilst also developing space technologies and creating new software/tools all with the concept of sustainable development at their core for the benefit of the orbital and Earth environment.

Glasgow Caledonian University (GCU)

GCU is a public university located in Glasgow which was formed in 1993 following a merger of The Queen's College and Glasgow Polytechnic. GCU's vision (embodied through its motto 'For the Common Good') is to transform lives through excellent education and research that is accessible and impactful for the people of Glasgow and communities locally, nationally and internationally. The values of access, excellence and impact are at the heart of the GCU Strategy 2030.

Metasat UK Initiatives

The Strathclyde Space Systems Database (SSSD)

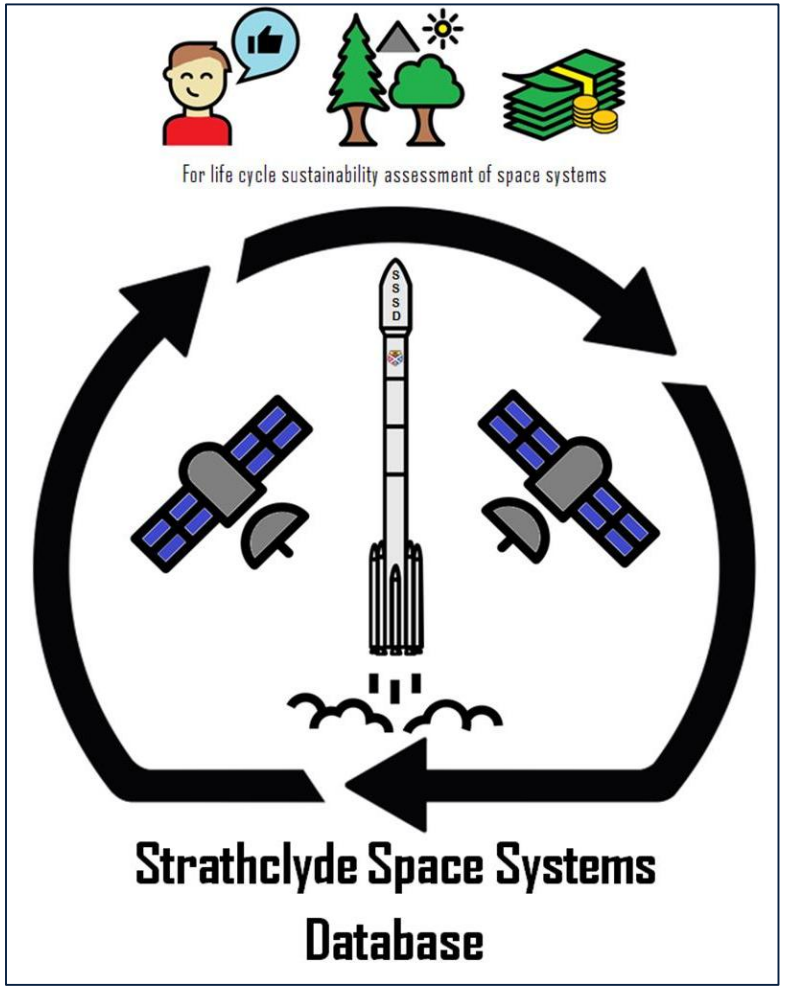
The world's first and only space-specific life cycle sustainability assessment (LCSA) database which can be used to calculate and reduce the sustainability footprints of space systems and integrate sustainability criteria into the space mission design process in a concurrent engineering environment.

Development and access to the SSSD is currently managed by Metasat UK Ltd on behalf of the University of Strathclyde. Requests for access can be made to: andrew@metasat.co.uk.

To gain access to the SSSD, you must provide proof that you hold an up-to-date and valid Ecoinvent license and then sign a EULA.

The full set of resources available include:

- The SSSD (.zolca file)
- SSSD Ecodesign Workbook (.xlsx file)
- SSSD User Handbook (.pdf file) – major update ongoing



A.R. Wilson, "Advanced Methods of Life Cycle Assessment for space systems," PhD thesis, University of Strathclyde, Glasgow, United Kingdom, 2019.

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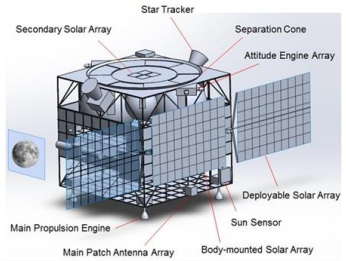
University of Strathclyde Glasgow

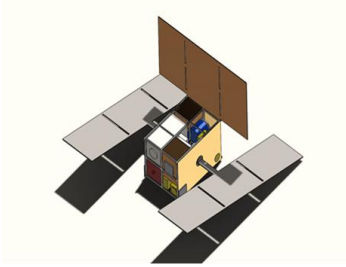
METASAT UK

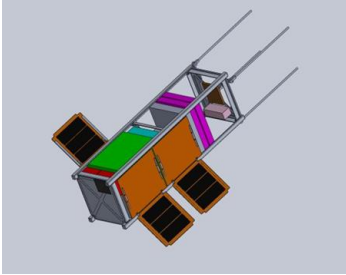
The Strathclyde Space Systems Database (SSSD)

The SSSD is used by stakeholders across 11 countries and 3 continents with case study examples outlined below:

Space system studies

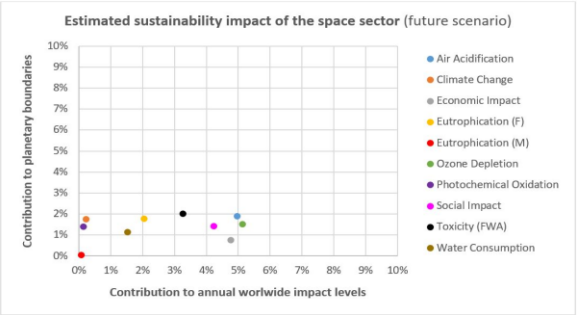




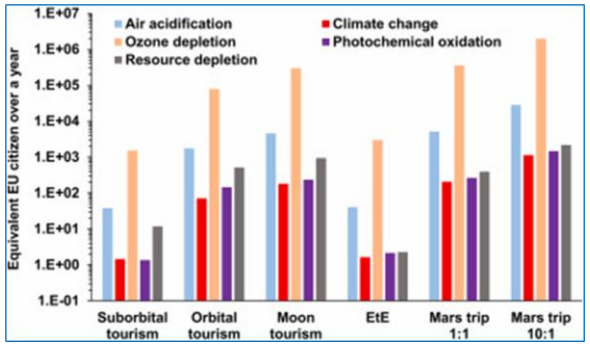


A.R. Wilson & M. Vasile, "Life cycle engineering of space systems: Preliminary finding," Advances in Space Research, Volume 72, Issue 7, October 2023, Pages 2917-2935.

Sector-wide studies

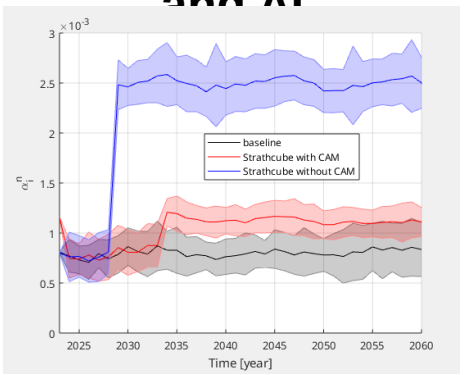


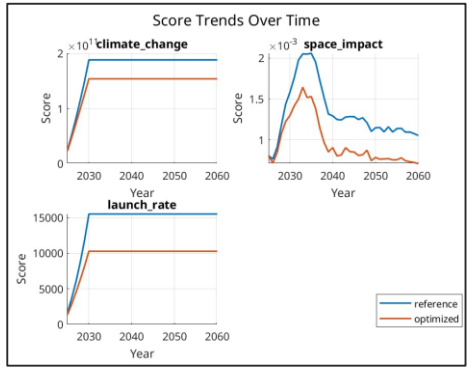
A.R. Wilson, M. Vasile, C.A. Maddock & K.J. Baker, "Ecospheric life cycle impacts of annual global space activities," Science of the Total Environment, Volume 834, 15 August 2022, 155305.



L. Miraux, A.R. Wilson & G.J.D. Calabuig, "Environmental sustainability of future proposed space activities," Acta Astronautica, Volume 200, November 2022, Pages 329-346.

Integrating orbital impact and AI





C.L. Alberti, Y. Wang, A.R. Wilson & M. Vasile, "A holistic approach to space sustainability: closing the loop between global space health indicators and life cycle assessment," in: 11th European Conference for Aerospace Sciences (EUCASS), Rome, Italy, 2025.

GCU Glasgow Caledonian University

GCU Research Projects

GCU
Glasgow Caledonian
University

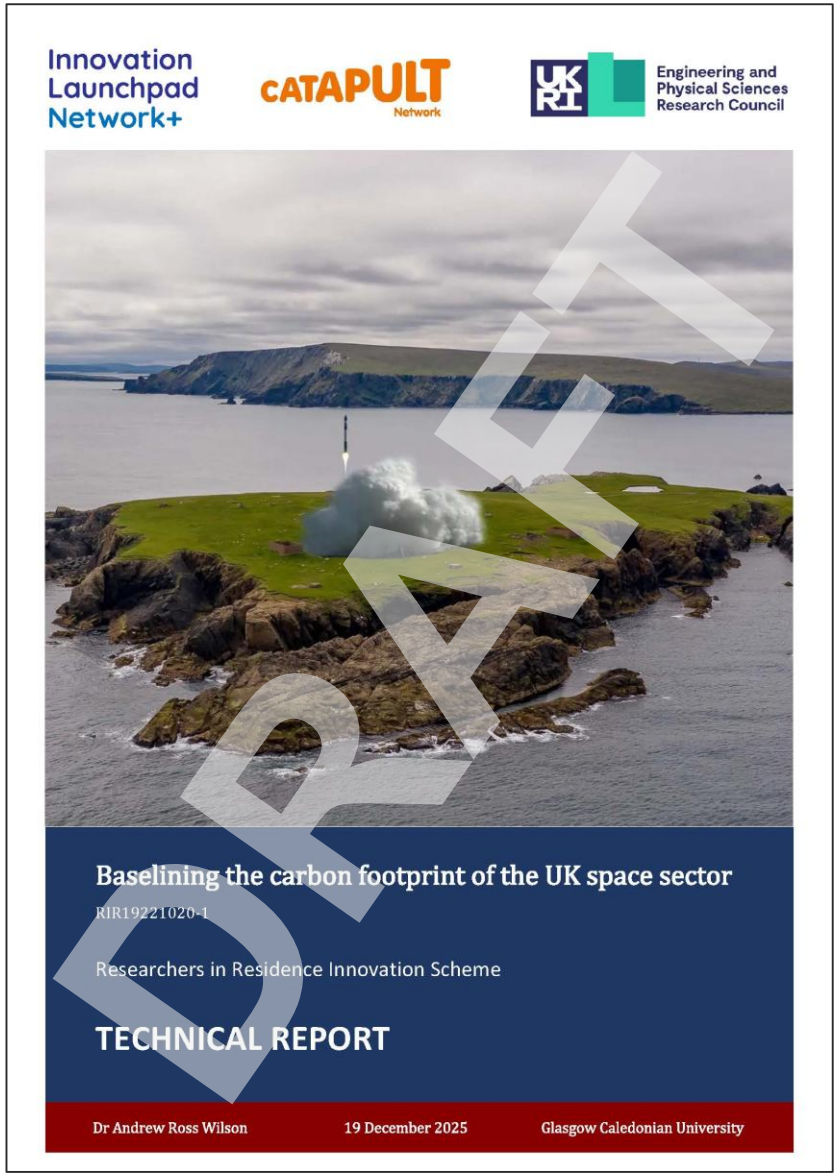
Baselining the carbon footprint of the UK space sector

Duration: Jan 2024 → Dec 2025

- This project is a collaboration between GCU, the Satellite Applications Catapult and Space4Climate, funded by the EPSRC's Innovation Launchpad Network+ Researcher in Residence Scheme.

- To produce the first ever carbon baseline of the UK space sector and provide recommendations on viable decarbonisation pathways in line with UK net-zero targets.

- The main technical report is about to undergo a third-party review and is expected to be released on 19 December 2025, with further research outputs (including a white paper, conference paper and journal article) to be presented in 2026.



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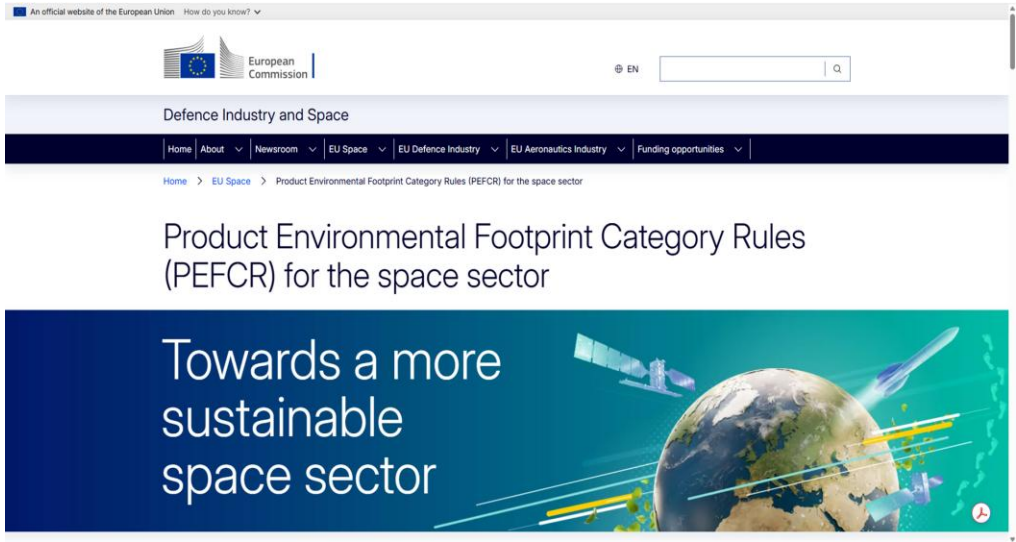
PEFCR for the space sector

Duration: Sep 2024 → 2027

- Mandated by the European Commission, the project is implemented by an external consortium consisting of VITO, PRé Sustainability, Ecomatters, Ecoinnovazione, GCU and NovaSpace.

- To establish a standardised method (PEFCR) for assessing and reducing environmental impacts across the EU space sector.

- GCU to conduct supporting studies alongside the development of the PEFCR to validate its applicability. These studies test whether the proposed modelling rules can be effectively applied to specific space products and assess how well the methodology functions in practice.



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Developing a simplified LCA-cost tool for space systems

Duration: 2026 → 2029

- Proposed PhD project currently under consideration by the ESA.
- To create a simplified LCA tool with integrated cost analysis, enabling decision-makers to evaluate the financial implications of sustainable life cycle decisions on early space mission design concepts.
- Please feel free to get in touch with Dr Andrew Ross Wilson if you are interested in hearing more or collaborating on this project.

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Miscellaneous

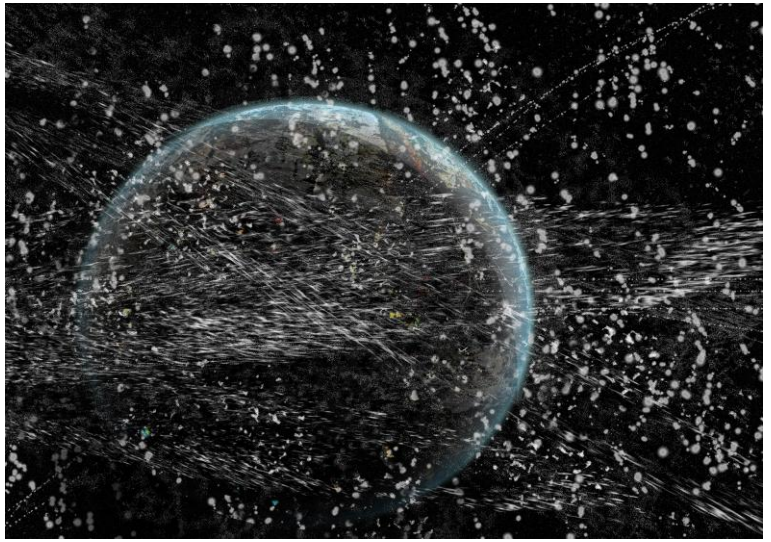
- GCU Research into the Space Economy (RISE).
- Staff involvement within the Space Scotland Environment Task Force.
- Staff involvement within the Cross-Party Group in the Scottish Parliament on Space.
- Staff involvement within the UK Space Energy Initiative Environment Working Group.
- Staff involvement within the Secretariat of ESA Technical Taskforce on LCA & Eco-Design for Space.

Key take aways

- Space sustainability is urgent and cross-cutting, requiring consideration of sustainability from space, sustainability in space and sustainability for space.

- Academic and industry initiatives must reinforce each other, rather than complete against one another. This has already been shown to be fruitful through Metasat UK Ltd's on-going collaborations with GCU and the University of Strathclyde in addition to the GCU-Strathclyde relationship.

- Please do get in touch if you are interested in any of the research presented, would like to explore potential future collaborations, wish to obtain access to the SSSD, or anything else!



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Thanks for listening!