Harmonized space LCA data for efficient eco-design

A common eco-design basis for the European space industry

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Clean Space Industry Days 2018
ESA ESTEC, Noordwijk, 23-25 October

NTNU Industrial Ecology
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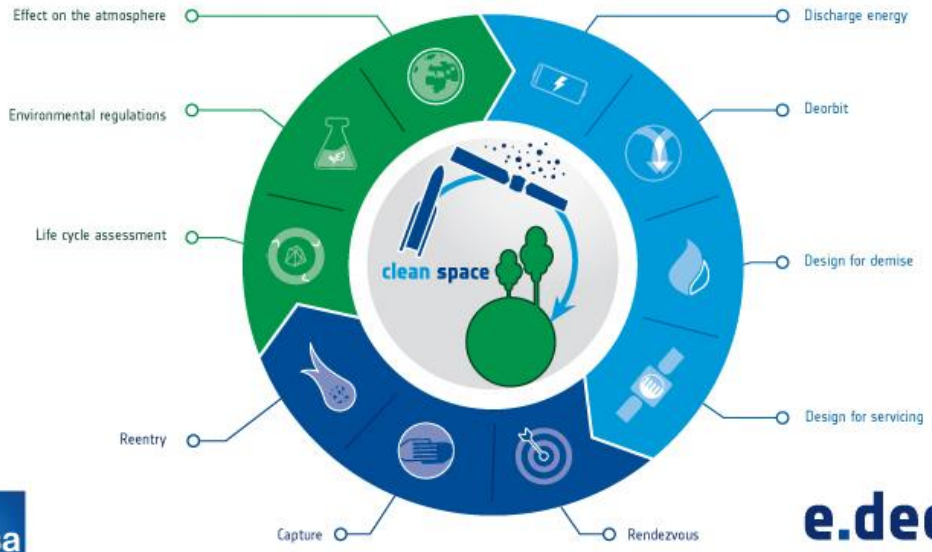
ecodesign

→ REDUCING IMPACTS

cleansat

→ SPACE DEBRIS REDUCTION



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→ ACTIVE DEBRIS REMOVAL

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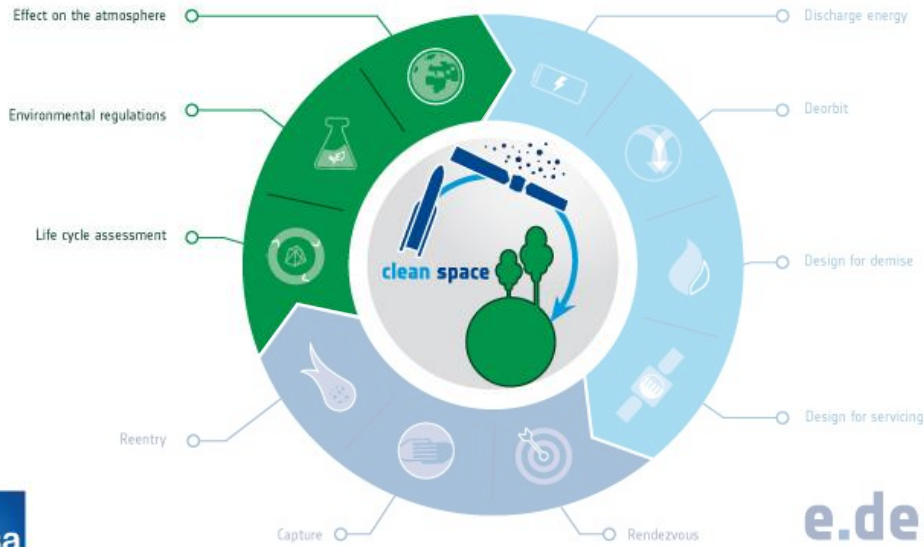

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Ecodesign & life cycle assessment

Ecodesign is designing products considering environmental impacts through the product life cycle.

Design with life cycle thinking.

http://www.learnlifecycle.com/

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Cradle-to-grave impacts.

- Compile emissions and resource uses
- Evaluate impact arising from these
- Interpret and use results

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Life cycle assessment provides the environmental information for ecodesign.

Development of LCA in ESA

- Before 2014: Early mapping of life cycle aspects: launcher etc
  - Mainly relying on materials from non-space applications
  - Examples: aluminium vs alloys, electronics, PVs…
- Database projects ESA Space LCI database 2015 & 2017
  - LCA data for space: materials, manufacturing, components, propellants
- Specific evaluation of missions & activities 2017
  - Projects relying on space LCA database

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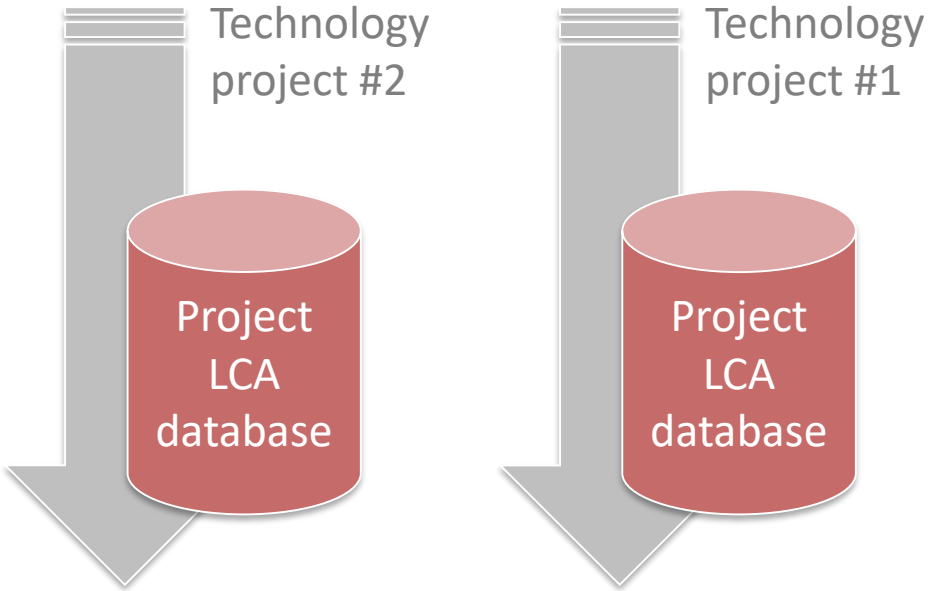
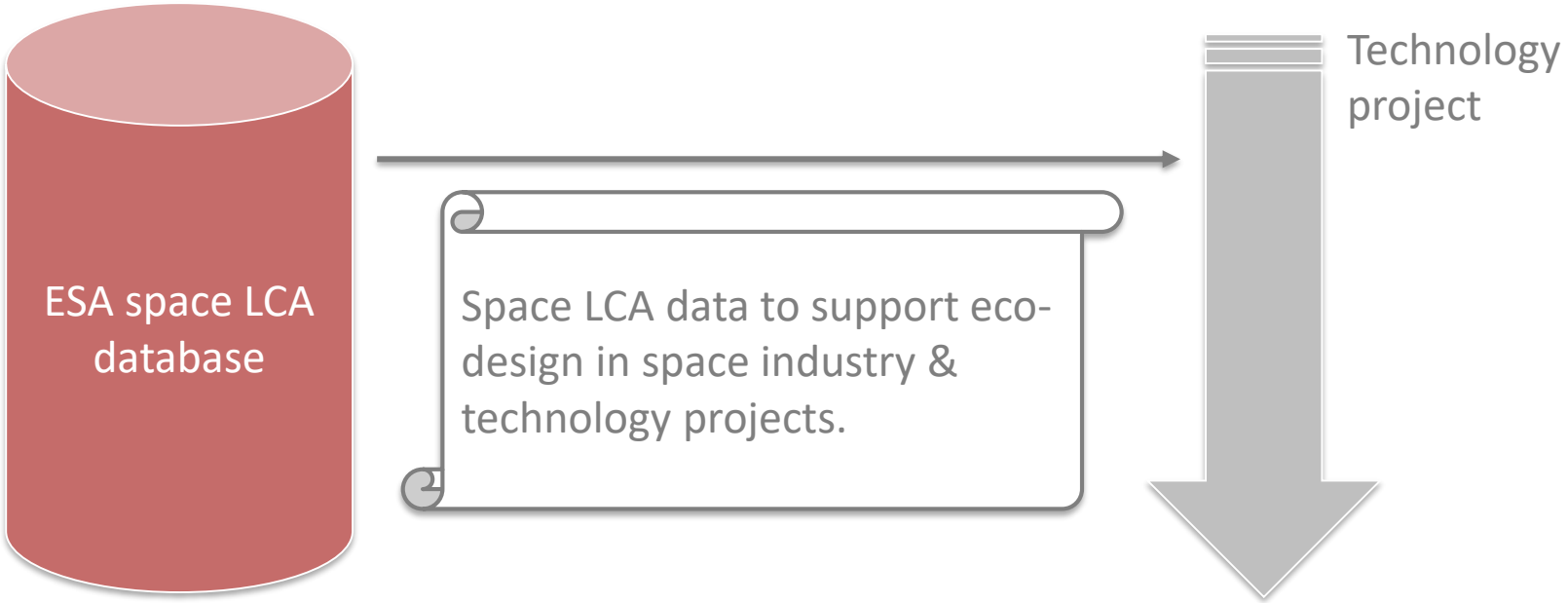
✓ **Future projects should add to the database**

Moving from technology projects completing LCA data…



… to technology projects using an LCA database…



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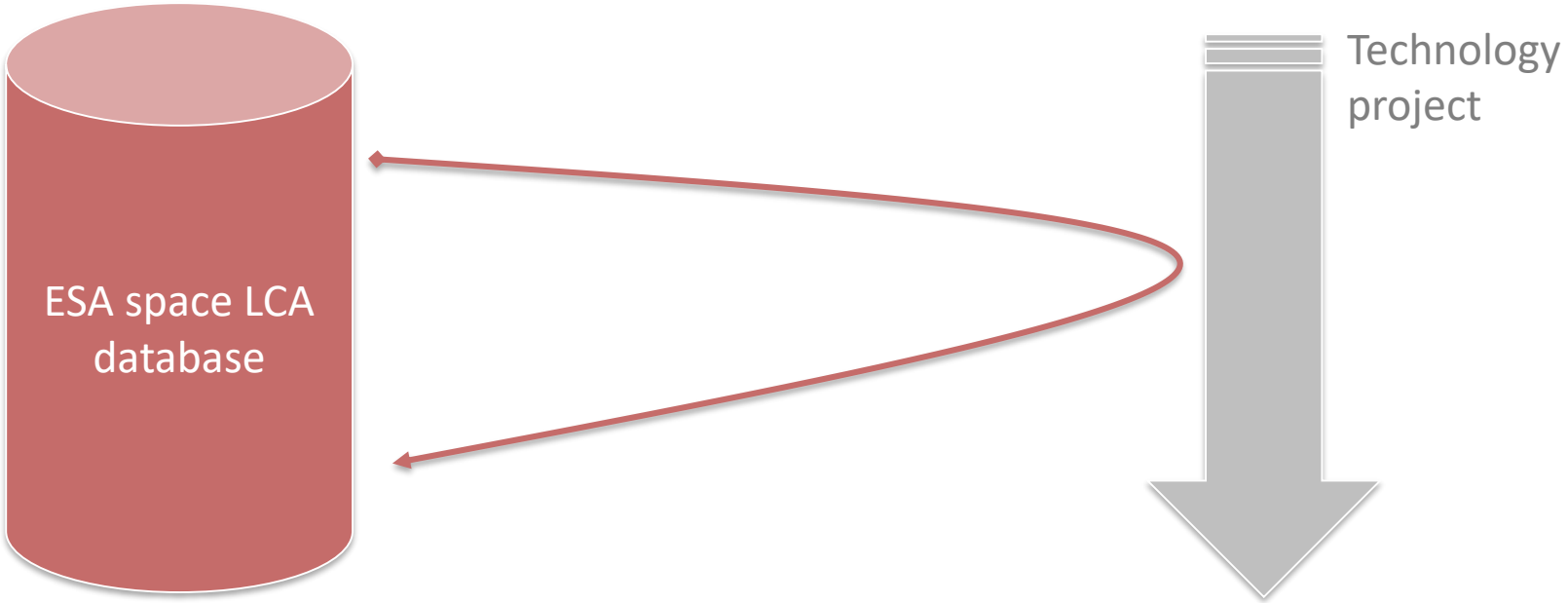

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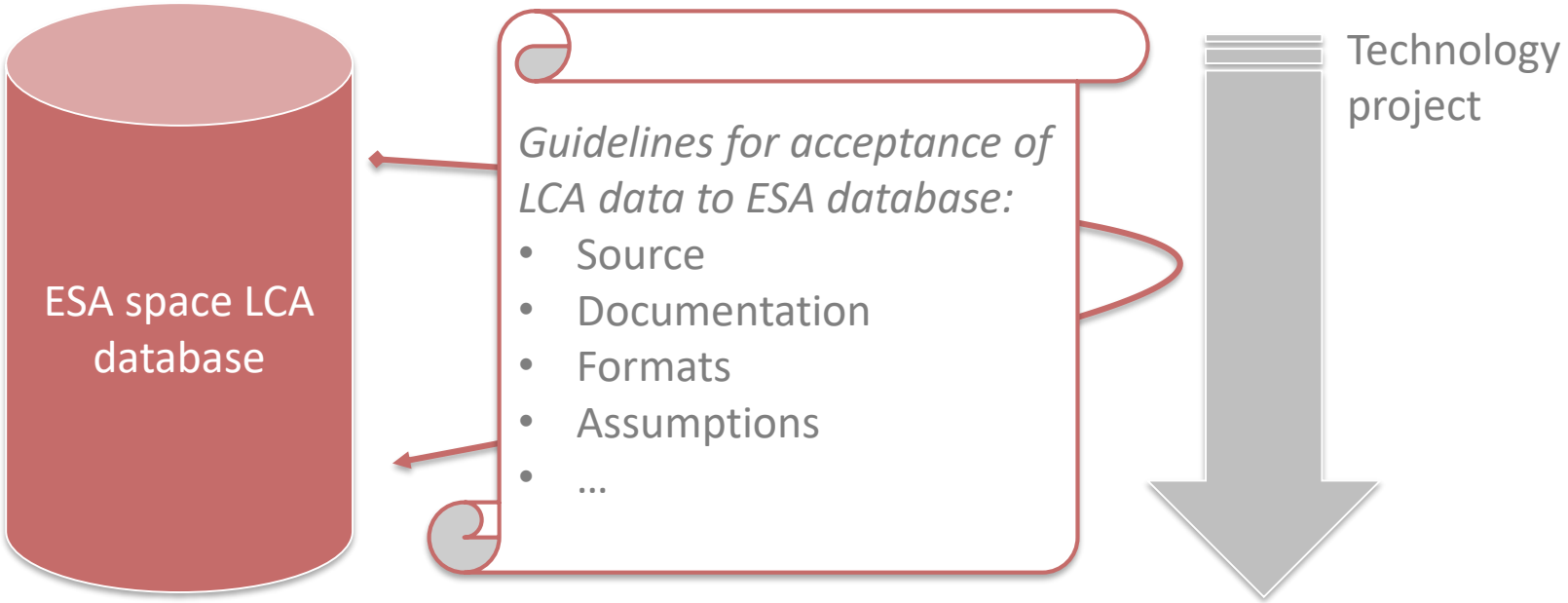


Starting point

- Space LCI 2015: materials, manufacturing & components
- Space LCI 2017: propellants
- GreenSat 2018
  - Sentinel 3
  - Proba V

Screening process – Pedigree matrix

Scoring of datasets by *data quality indicator* (DQI) for revised database

- Technology representiveness
- Geographic representiveness
- Time representiveness
- Comprehensiveness & coverage
- Precision & uncertainty in data sources
- Methodology

Currently covered

> 1 000 unique, space-specific elements

- Space materials & manufacturing processes
- Space propellants production
- Energy, logistics & waste treatments
- Space systems (components)
  - Electronics, batteries, PV systems, harness etc
  - Spacecraft equipment: propulsion, payload, stuctures
  - Tanks

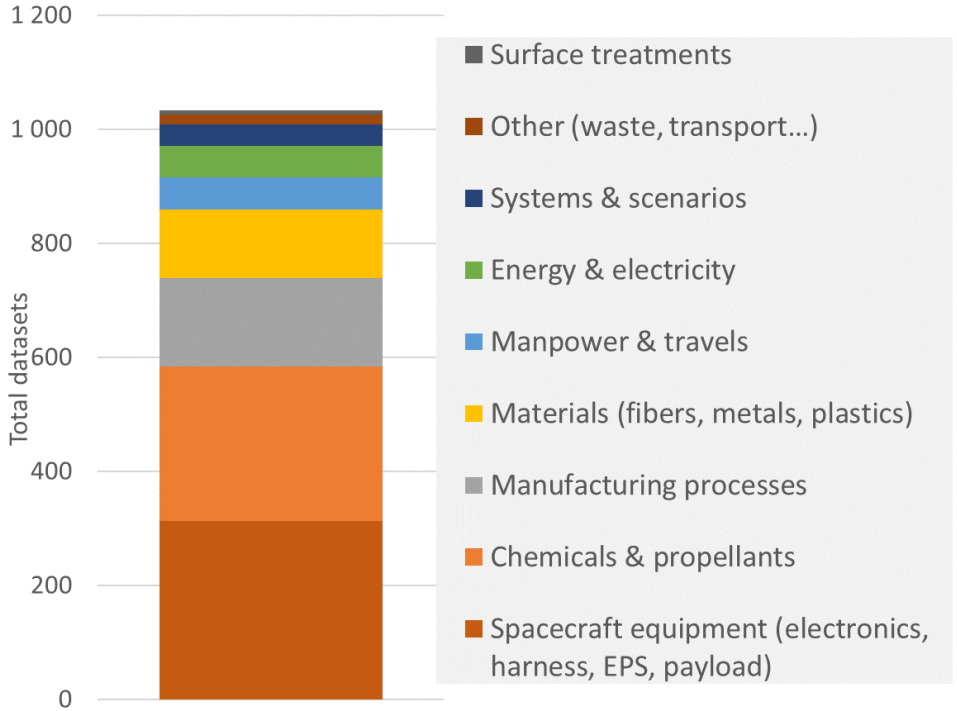
Examples

ESA - Spacecraft Equipment	AOCS		13
	Communication		13
		Antennas	2
	Electric Propulsion		1
		Tanks	40
		Thruster	2
	EPS		3
		Batteries	35
		PCDU	25
		Solar array	35
	Harness		25
	OBDH		2
		Electronics	7
	Payload		43
	Satellite adapter		1
	Structures		15
		Structural elements	23
	Thermal Control		11

ESA - Metals	Aluminium	Al 7000 alloys	5
		Al Li alloys	6
		Al per use	35
		Al Si Mg Alloys	9
		Not used	1
	Copper		5
	Others		10
	Powder production		2
	Stainless steels		12
	Titaniums		9
	Tungsten		1

Currently covered

ESA space LCA database



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Gaps

- Surface treatment
  - Potentially critical, cf. Al anodizing
- Constantly new materials
  - Experience from GreenSat
- Propellants dominate impacts
  - E.g., Ariane 64, should be validated
- Spacecraft equipment
  - Complex systems with large variation
- Manufacturing
  - Additive manufacturing
  - Conventional manufacturing should be validated

General guideline

- ESA member representation, not country-specific
- Link to ESA database where relevant for «space» context
- Documentation: specify how data are made
  - Source & approach (specific vs. general, estimation or emprical)
  - Assumptions & calculations, with reasoning
    - Science = replication (can someone else follow and find same conclusion?)
  - Naming convention (really!)
  - Software & format of implementation, is MS Excel acceptable?
  - Uncertainty & variation necessary for decision support
- Data quality requirements & guideline for (non)acceptance in development

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Golden rule of LCA

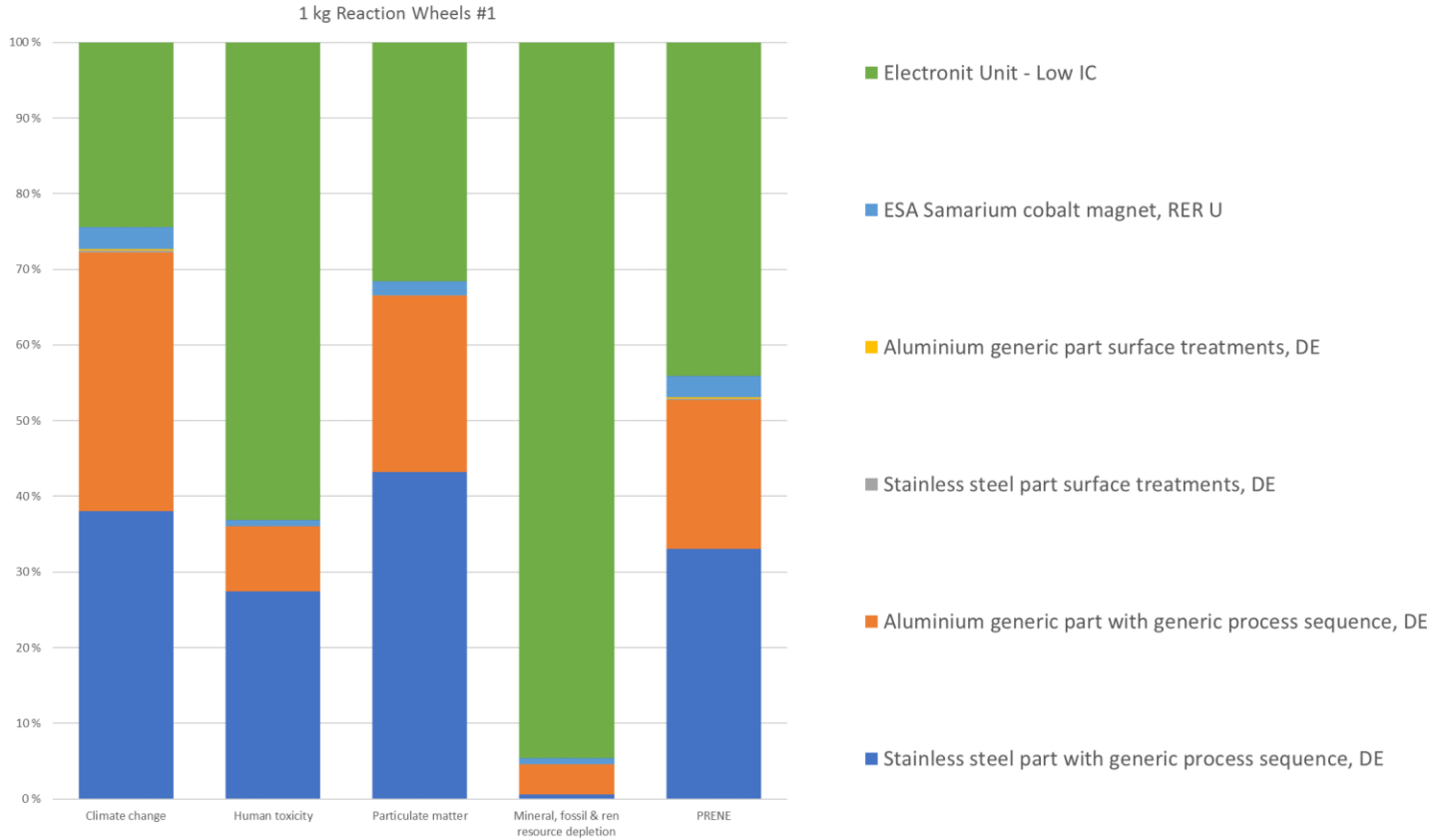
YOU ARE MAKING DATA FOR SOMEONE ELSE TO USE

Challenges for further expansion

- Generalizing sensitive data
- Large portfolio of materials used for space
- Significant variation between components & missions
- Surface treatment & manufacturing vs material inputs (bill-of-material paradox)
- Spacecraft equipment a large category

Comparison of two reaction wheels

Comparison of two reaction wheels – the simple LCA



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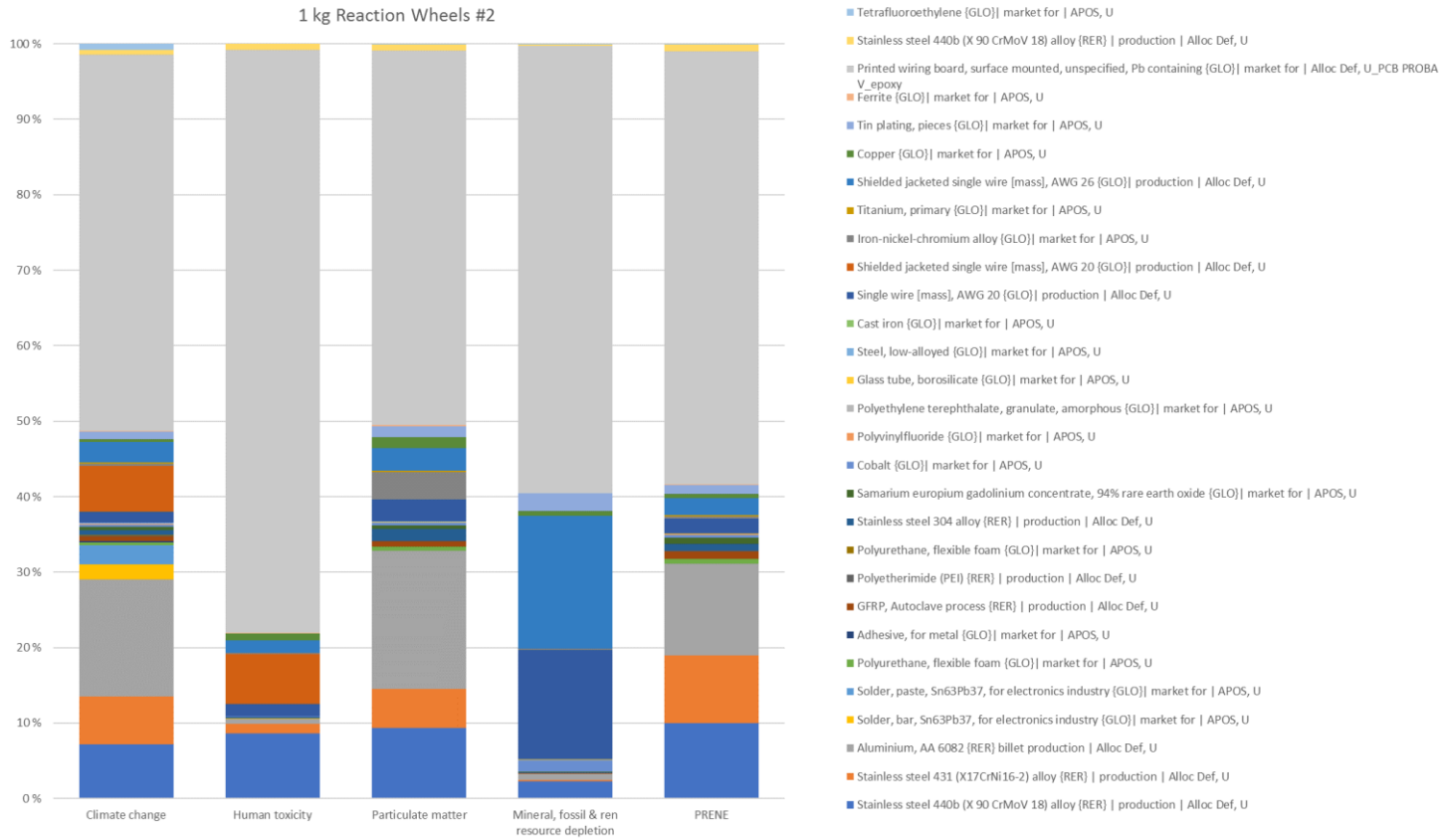

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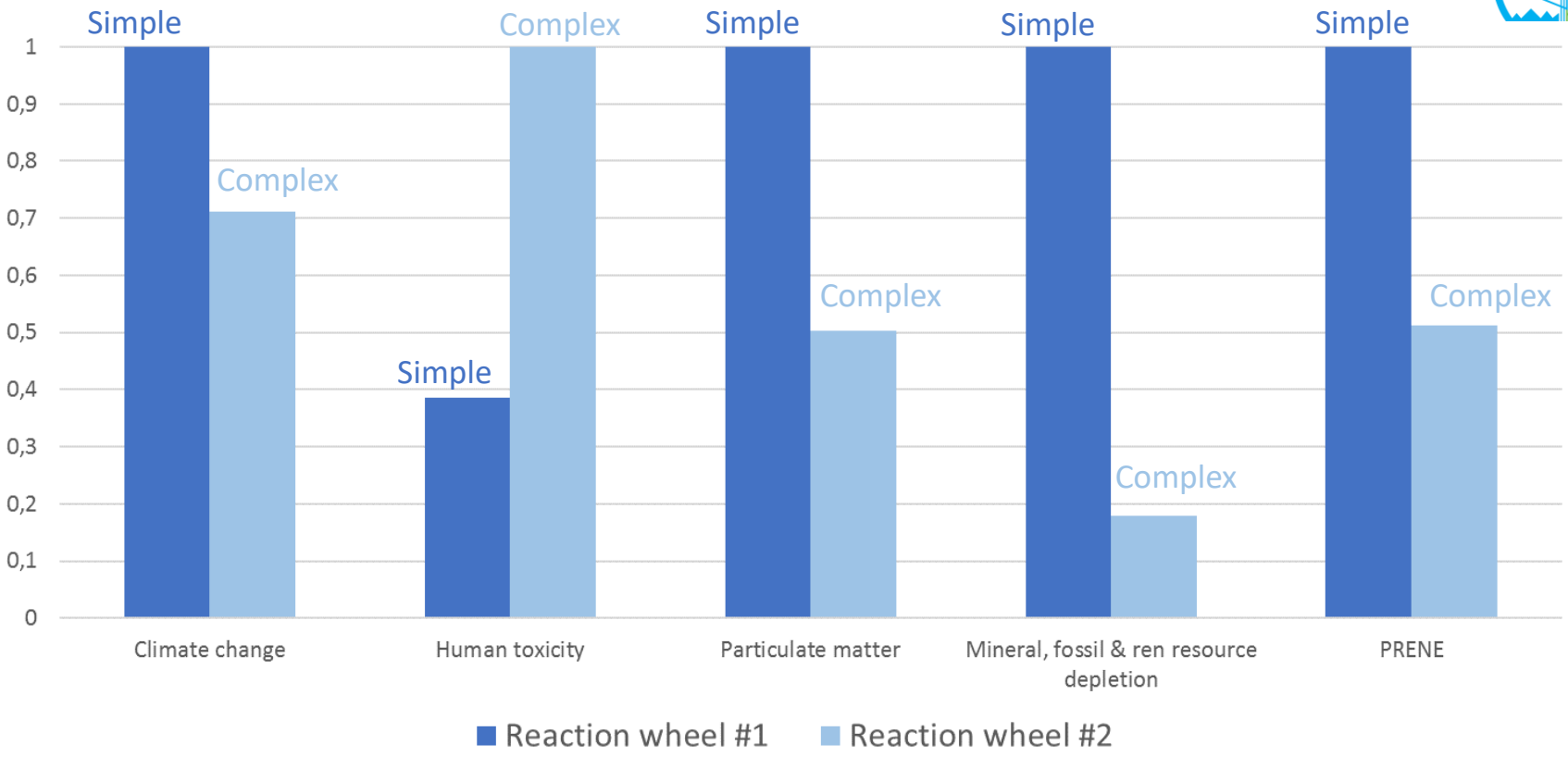

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A common basis to support ecodesign for space systems

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