ESA Life Cycle Assessment Database (Space LCA DB)
A guided tour

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ESA Clean Space Industry Days 2021 (online)

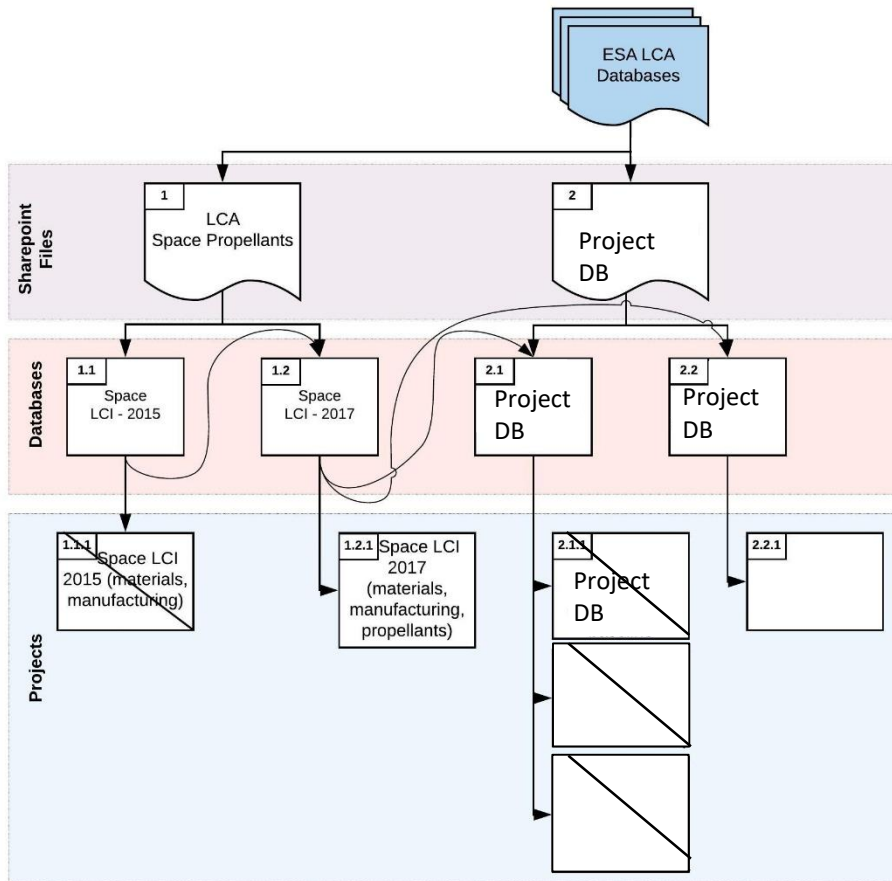Session Eco-design for space Tuesday 21st 2021

NTNU Industrial Ecology
Norwegian University of Science and Technology

Agenda

1. Short presentation: history and development
2. Demonstration

Database developed in 2 generations
Applications to various space systems

➤ Close to 4 000 datasets in total

- Align all and update to Ecoinvent 3.5, SimaPro 9.0
- Change background to *Cut-off*
- Consistent energy system (Europe/RER)
- Consistent material system
- Restructure & replace folders

- Identify unique inventories
- Screen for quality and documentation
- Introduce consistent methodology

➤ 1 013 unique datasets

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MATERIAL

ESA – Chemicals: *Production of chemicals: gases, inorganic and organic chemicals, and propellants.*

ESA – Electronics: *Electronic devices and components.*

ESA – Launch segment (Internal DB only): *Launch campaigns and preparation*

ESA – Manpower & travels (Internal DB only: *Operation of centres, office work and man-years at ESA and suppliers: ground station, mission control centre, mission data centre, mission operation centre.*

ESA – Materials: *Production of materials: carbon fibre and resins, fiber reinforced polymers, glass, thermoplastics.*

ESA – Metals *Production of metals and minerals: aluminium alloys, ferro (steel and stainless steels), non-ferro metals and minerals (Cu, Be, Ti, V, tungsten, magnets), and metal powders.*

ESA – Missions (Internal DB only): *ESA missions: Proba V, Sentinel 3B.*

ESA – Propellants: *Provision of propellants for launcher and spacecraft, separated between loaded electric, "solid, hybrid, high-thrust", and storable, and loading of propellant components (individual fuel or oxidizers).*

ESA – Spacecraft equipment (some elements in Internal DB only: "Payload", "STM"): *Production of spacecraft equipment: AOCS, communication, EPS, harness (meters and mass), OBDH, payload, propulsion, robotics, STM, structures, tanks. These elements in mass only and as system processes.*

ENERGY

ESA – Energy : *Energy supply processes: electricity, heat and cooling.*

TRANSPORT

ESA – Transport: *Transport operations specific to ESA components.*

PROCESSING

ESA – Manufacturing processes: *: additive manufacturing (various technologies: steel, al, Ti)), bake-out, gas atomization, nozzle extension, polymers, and sanding.*

ESA – Metals processing: *chipless, chipping, coating, plating and surface treatment, heat treatment, welding, general metal working.*

ESA – Propellant handling: *Processes involved in propellant handling other than production: decontamination and waste treatment, fuelling, containers and storage.*

ESA – Testing and inspections: *Various testing and inspection operations, including: eddy current, clean room use, dye penetrant, leak test, pressure cycle, proof cycle, ultrasonic, x-ray/radiography etc.*

ESA – Waste: *Waste treatment, currently very few LCIs.*

WASTE TREATMENT

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In total approx. 1 013 unique datasets for space systems

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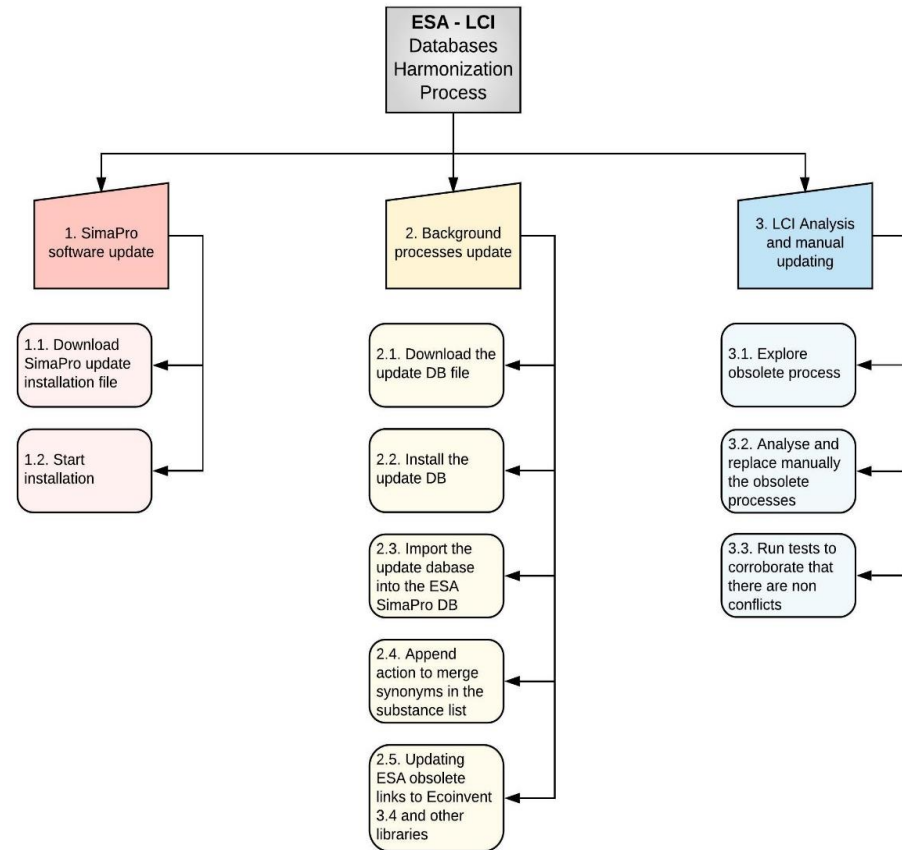**ESA – Waste**: *Waste treatment, currently very few LCIs.*

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Harmonisation process

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Guideline for development of new datasets

DOCUMENTATION ASPECT CORRESPONDANCE	
Mission Data (report)	**Inventory – Documentation (LCI in SimaPro)**
• Author	• *Generator* (name and entity of person(s))
• Functional unit	• *Name,* unit and geographical location of output(s)
• Date	• *Date*
• Goal and scope	• *Data treatment* (calculations etc) • *Collection method* (survey, measurement, literature etc) • *Status* of LCI (draft, complete, etc) • *Data quality ranking (DQR)* overall score and judgement: "high quality" (DQR<1.6), "basic quality" (DQR 1.6 – 3.0), "data estimate" (>3)
• Brief introduction to the LCA mission • LCA type • Reason for study • Commissioner • Mission name • Possible confidentiality	• *Comment*, for remaining elements and judgement of representativeness. • *Comment,* whether data is confidential and only intended for internal use in ESA or also available to other space industrials.

Public user manual (UM1)

- Naming convention
  - *Hydrogen, gaseous, methanol reforming, propellant {French Guinana} | production | Cut-off, U*
  - *Name, characteristics {location} | process type | methodology, Unit or System process*
- Use folder structure
- Minimum requirements -> Guideline & Questionnaire
  - Documentation
  - Data quality ranking (DQR)
- Comments (meta-data)
  - Transport, if included
  - Short description
  - Context, by whom and for what purpose

And now the guided tour

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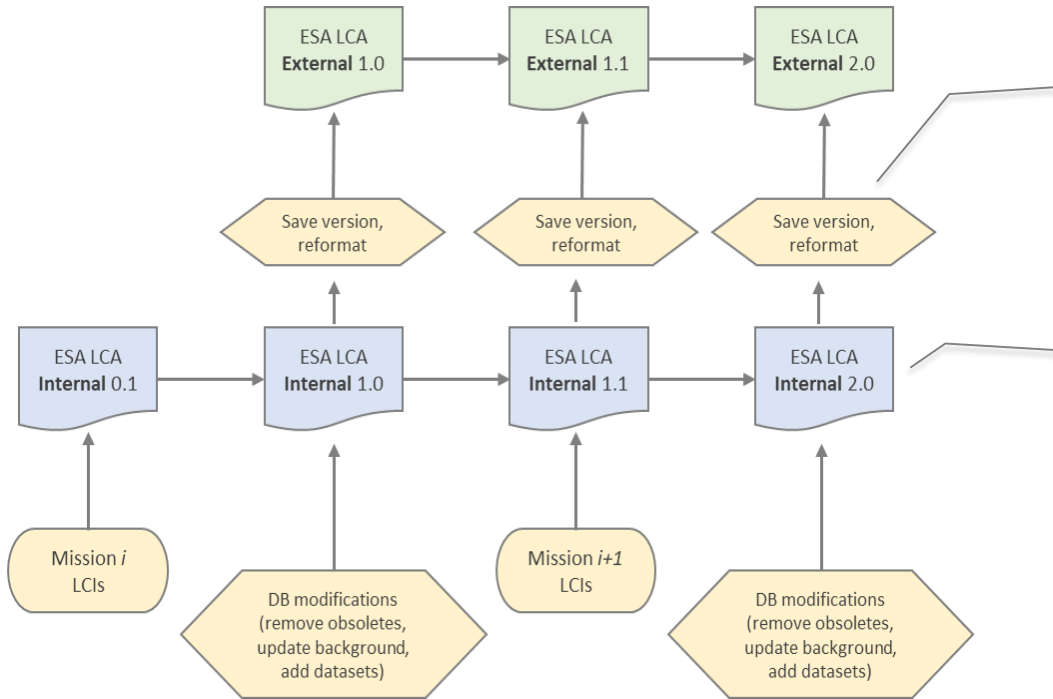johan.berg.pettersen@ntnu.no

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Questions?

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Procedure for updates in external & internal database

Update **external** version

1. Documentation
2. System process conversion
3. Scaling factor

Update **internal** version

1. Naming convention
2. DQR evaluation
3. Remap new inventories to unit processes
4. Version control