

UNCLASSIFIED



G2SB1

Life Cycle Assessment

First iteration results

DEFENCE AND SPACE

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AIRBUS

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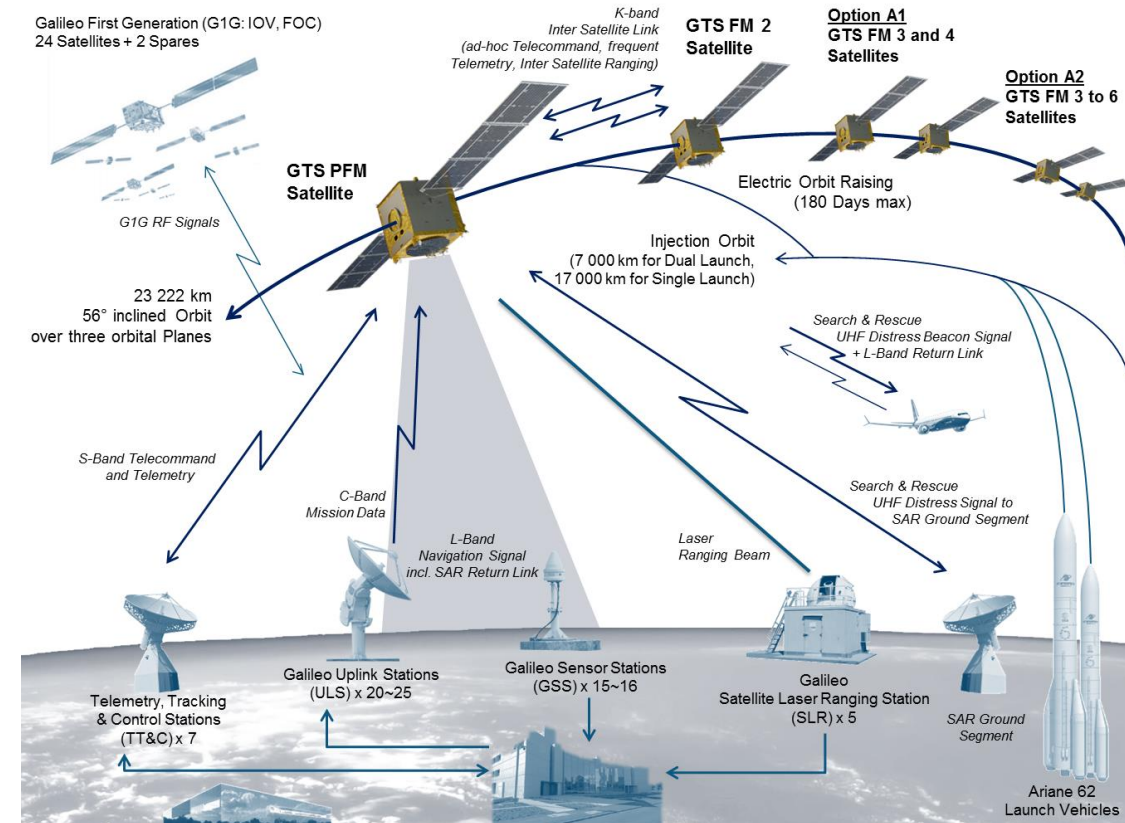
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Agenda

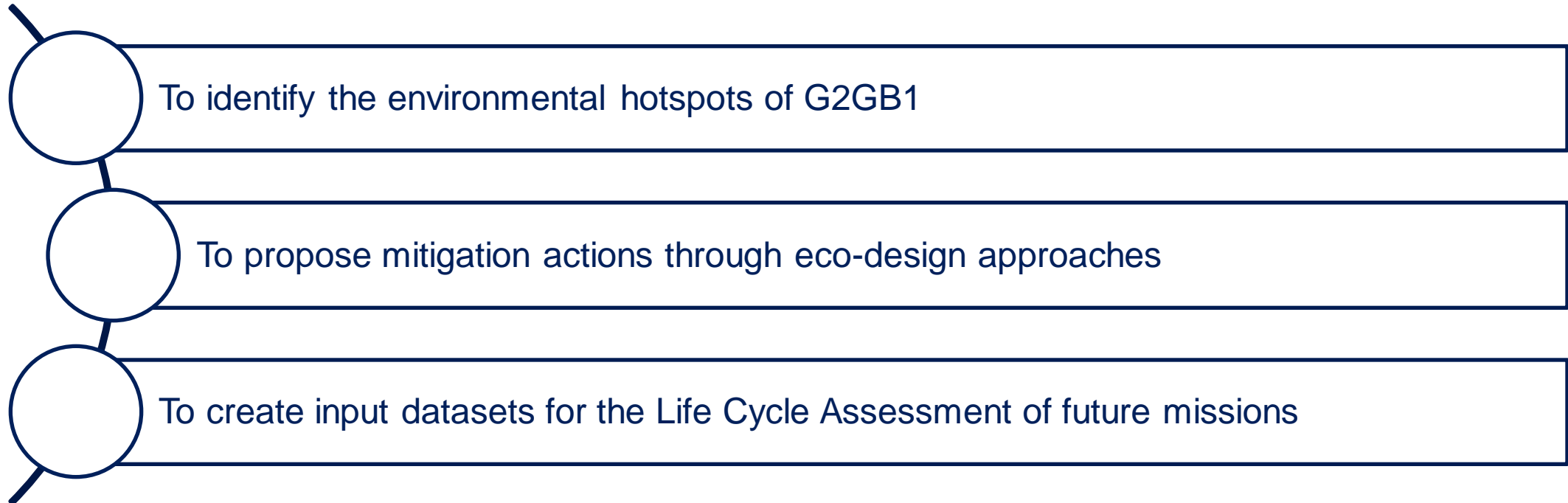
- Galileo Satellite
- Goal of the LCA study iaw ESA G2G SoW
- From Scope definition to LCA model: A step-by-step process to model all key activities within scope
- System Boundaries
- LCA results
- Conclusions

Galileo Satellite

- Galileo Space segment comprises an in-orbit set of 24 operational and up to 6 spare satellites in MEO.
- Navigation and Search and Rescue (SAR) Services
- The first generation of the Galileo constellation will be replenished by the Galileo Transition Satellites (GTS).
- Under the G2SB1 contracts, Airbus is providing 6 satellites.
- Design lead by Airbus FDH (Prime)
- Designed based on independent modules (Core Team)
 - Navigation Payload managed by Airbus OTN
 - Inter Satellite Link Module (ISLM) provided by TESAT
 - Electrical platform (including propulsion module) based in Airbus TLS Telecom heritage.



Goal of the LCA study iaw ESA G2G SoW

- 
- To identify the environmental hotspots of G2GB1
 - To propose mitigation actions through eco-design approaches
 - To create input datasets for the Life Cycle Assessment of future missions

From Scope definition to LCA model

A step-by-step process to model all key activities within scope

Scope definition:

FU: *“The definition, manufacturing, integration, qualification, testing and preparation for launch of the Galileo Second Generation Satellite Batch 1 space segment to fulfil its requirements”.*

Impact indicators: PEF methodology (EF3.0)



Data collection:

- G2G proposal
- G2G product tree and mass budget
- G2G contracts
- G2G schedule and logistics plan
- LEO mission similar equipment LCI
- G2G equipment (EQSR, Mass budget, test plans, DML, DPL)
- Airbus facilities management
- ESA LCA Handbook and TNs
- Literature



Mapping of inventories

(Ecoinvent database)



Modelling in LCA software

(Gabi software)



System Boundaries

Phases A+B – Feasibility and Preliminary definition

- Labour hours
- Staff travels by plane

Phases C + D – Detailed definition + Qualification and production

- Labour hours
- Staff travels by plane
- Equipment material composition and some manufacturing processes
- Transport of assembled equipment and modules
- Testing at equipment and satellite level
- Propellant production

Phase E1 – Launch and commissioning, limited to spacecraft related activities

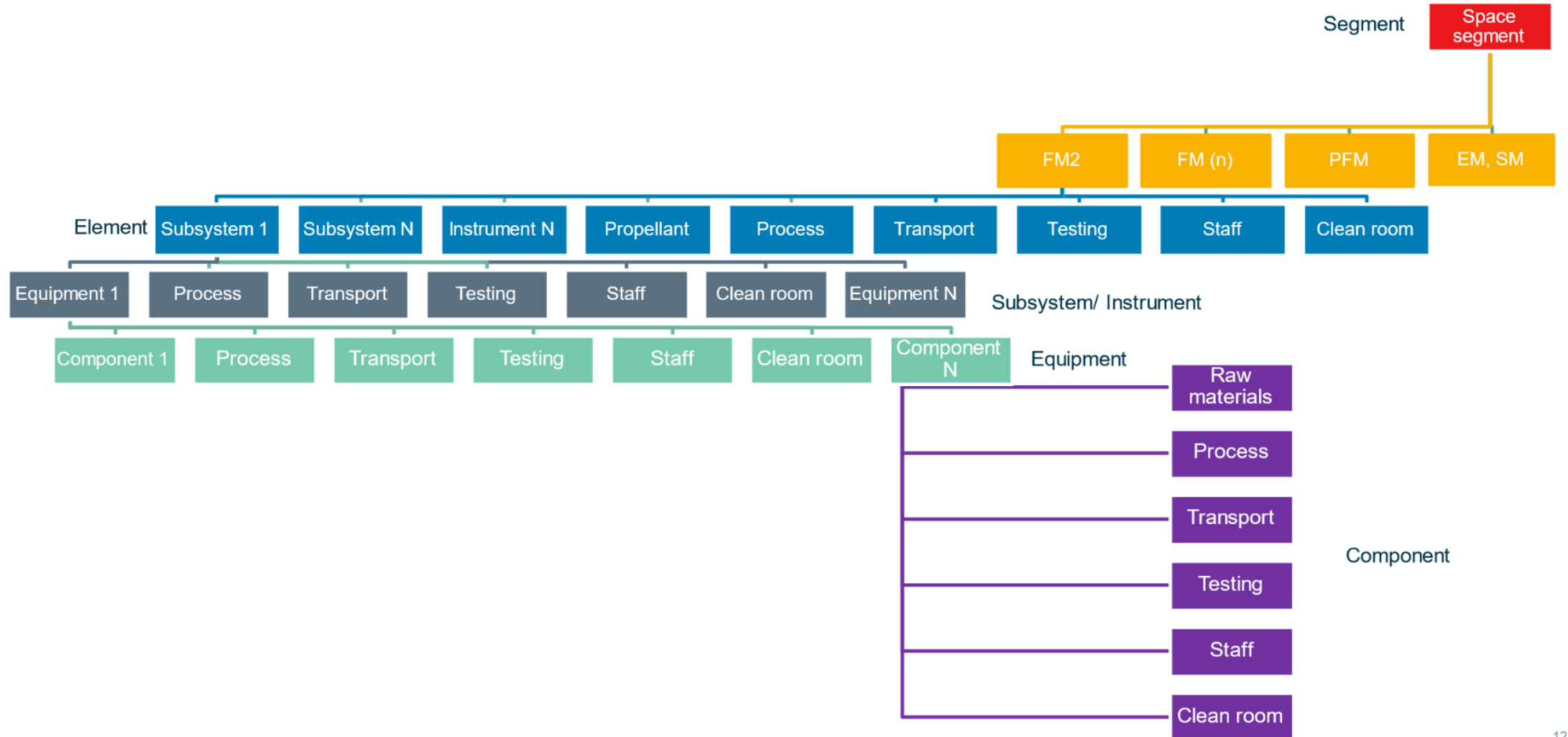
- Labour hours
- Staff travels
- Spacecraft and GSE transport to launch site

Phase F – Disposal (partially included)

- Transport from launch site to Europe (GSE and containers)

Modular modelling strategy

(ESA modelling guidelines)



LCA results: PFM (all phases)

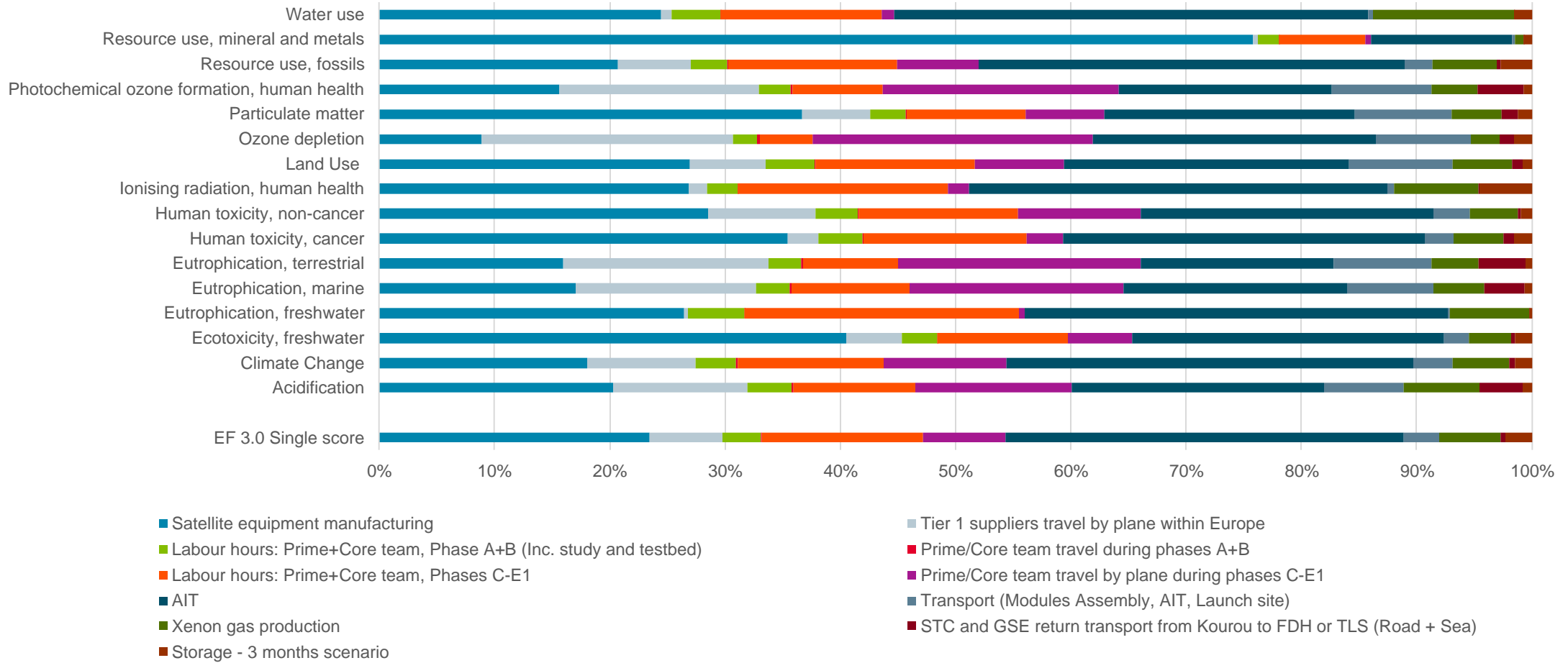


Figure 1: Impacts breakdown of the different phases within scope, for PFM – Functional Unit: “The definition, manufacturing, integration, qualification, testing and preparation for launch of the Galileo Second Generation Satellite Batch 1 space segment to fulfil its requirements”

LCA results: PFM (all phases)

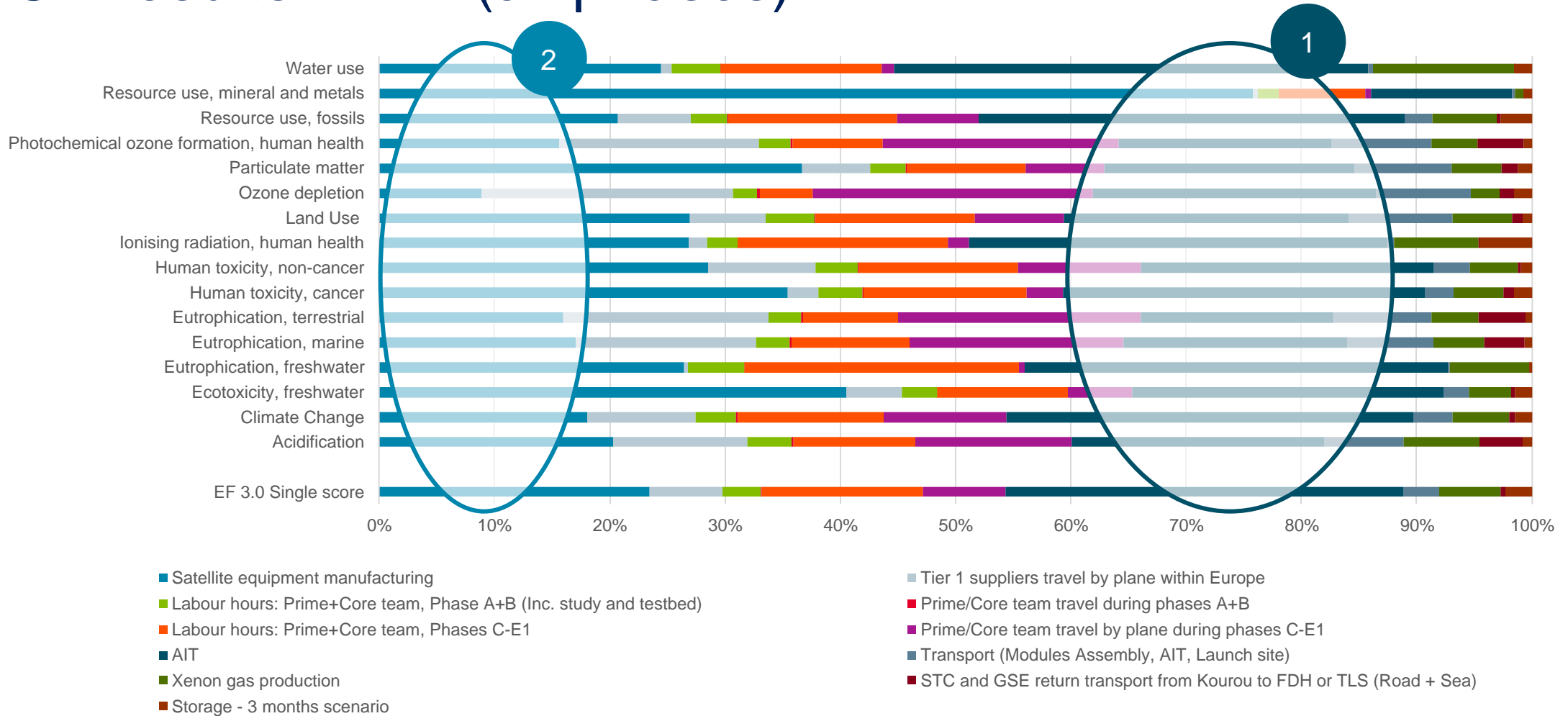
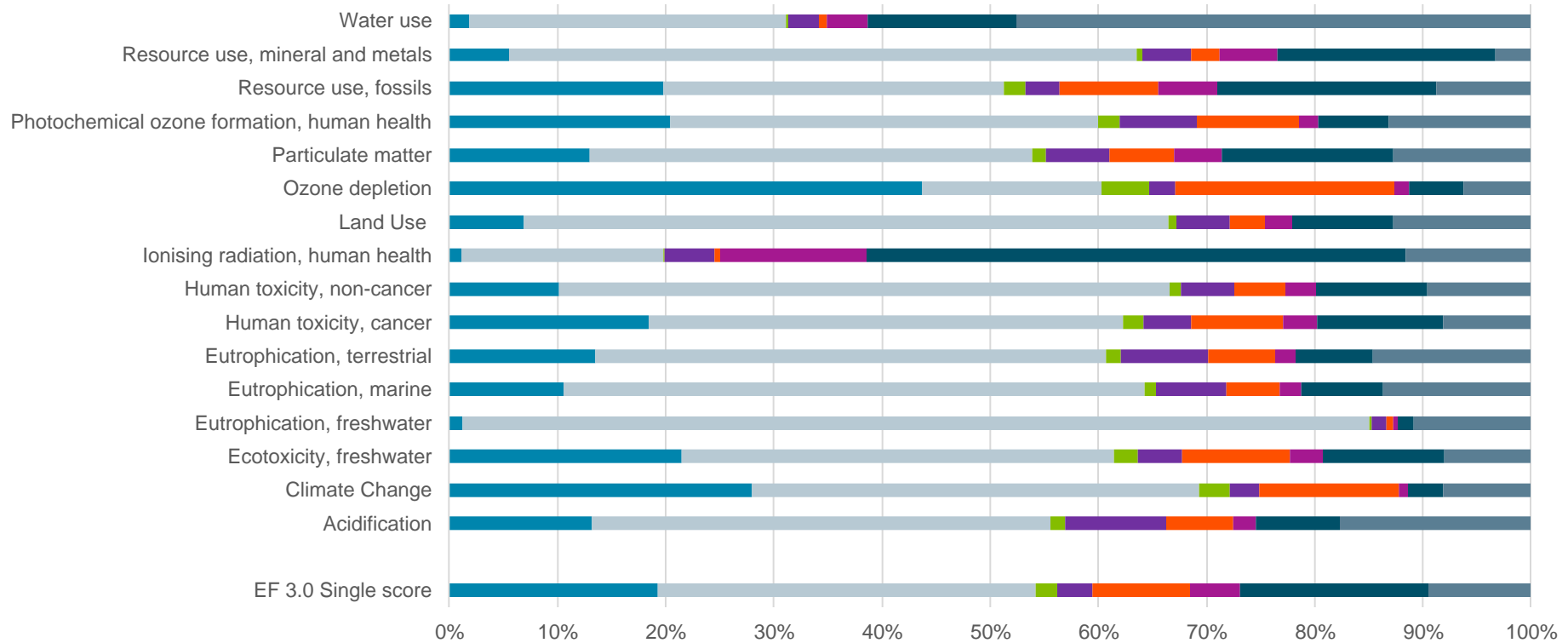


Figure 1: Impacts breakdown of the different phases within scope, for PFM – Functional Unit: “The definition, manufacturing, integration, qualification, testing and preparation for launch of the Galileo Second Generation Satellite Batch 1 space segment to fulfil its requirements”

LCA results: PFM AIT



- Clean room usage in Germany: natural gas consumption
- Clean room usage in Germany: electricity consumption
- Clean room usage in Spain: natural gas consumption
- Clean room usage in Spain: electricity consumption
- Clean room usage in France: natural gas consumption
- Clean room usage in France: electricity consumption
- Environmental testing at Satellite level: electricity consumption in France
- Environmental testing at Satellite level: LN2 consumption

Figure 2: Impacts breakdown of the AIT phase, for PFM – Functional Unit: “The definition, manufacturing, integration, qualification, testing and preparation for launch of the Galileo Second Generation Satellite Batch 1 space segment to fulfil its requirements”

LCA results: PFM Equipment manufacturing

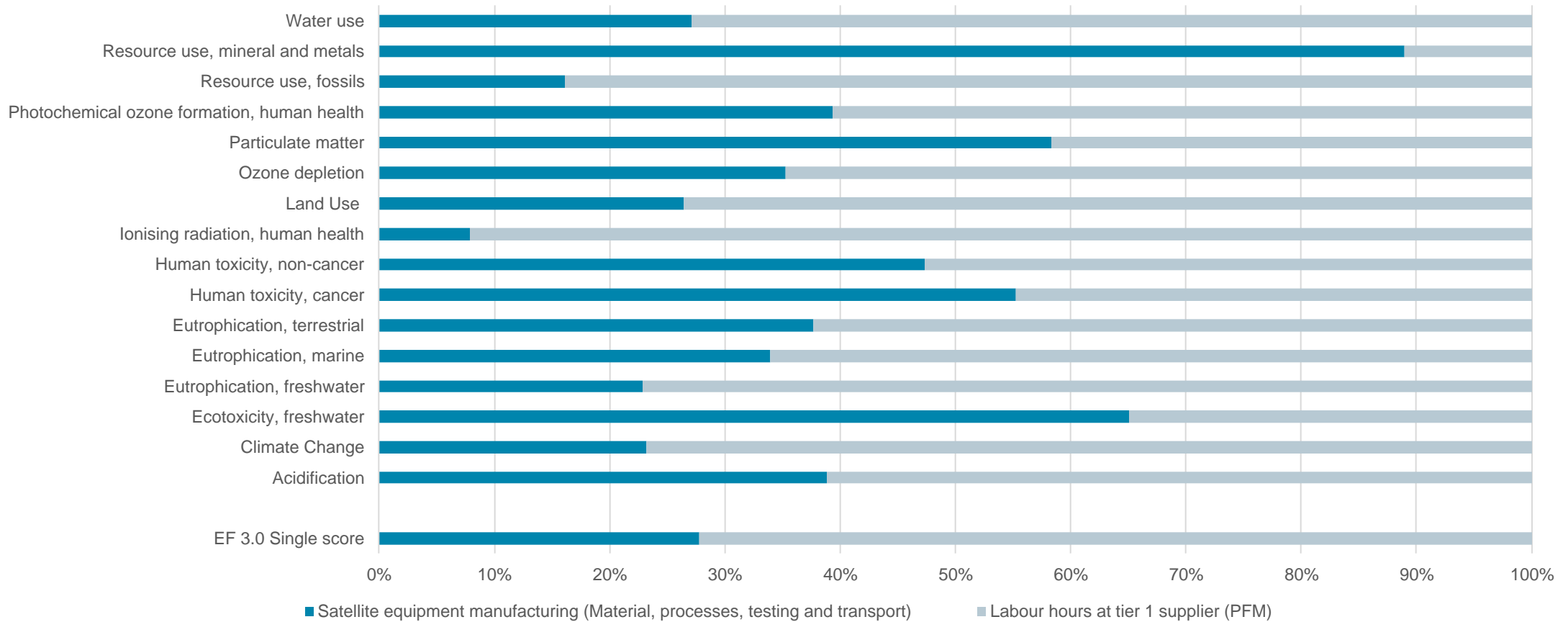
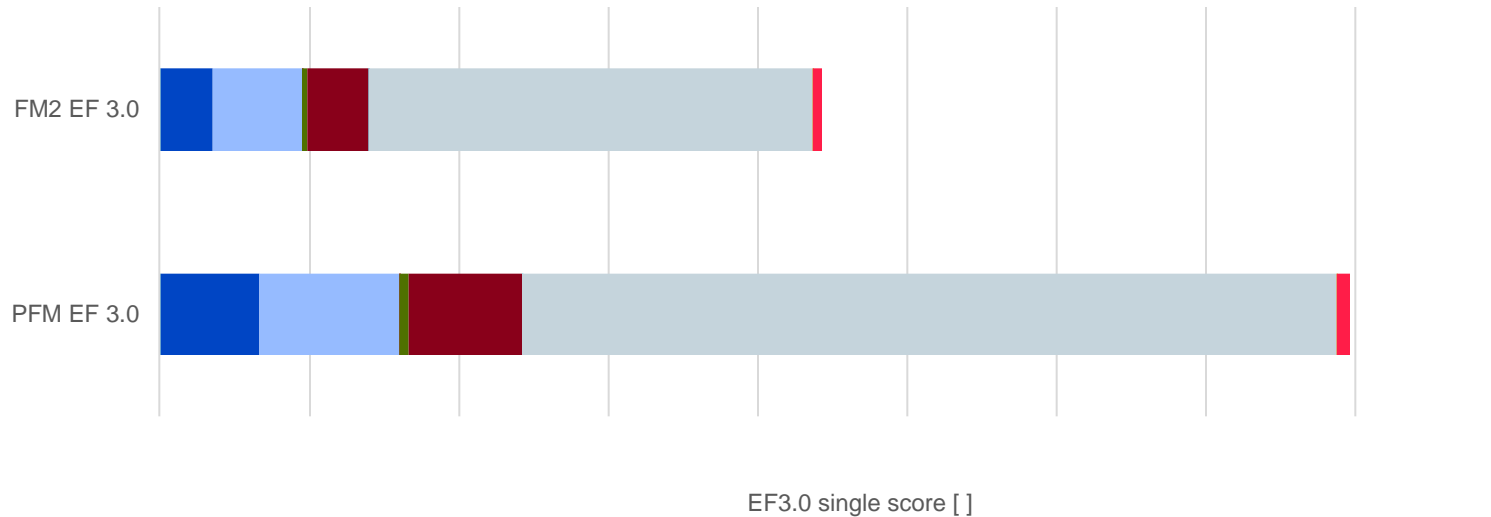


Figure 2: Impacts breakdown of the manufacturing phase, between “Labour hours at tier 1 supplier” and “Materials, processes, testing and transport”, for PFM – Functional Unit: “The definition, manufacturing, integration, qualification, testing and preparation for launch of the Galileo Second Generation Satellite Batch 1 space segment to fulfil its requirements”

LCA results: Single score



- Acidification
- Climate Change
- Ecotoxicity, freshwater
- Eutrophication, freshwater
- Eutrophication, marine
- Eutrophication, terrestrial
- Human toxicity, cancer
- Human toxicity, non-cancer
- Ionising radiation, human health
- Land Use
- Ozone depletion
- Particulate matter
- Photochemical ozone formation, human health
- Resource use, fossils
- Resource use, mineral and metals
- Water use

Environmental hotspots

- **Resource use, fossil + Climate Change + Land use** – energy consumption, originating mainly from working hours and AIT.
- **Ecotoxicity**– extraction of the metals used as primary materials in electronic components.

FM2 vs PFM

The FM2 LCI differs from the PFM LCI in the following aspects:

- Spare parts not included
- Test sequences less demanding
- No storage
- Less labour hours
- Less travels

Conclusions, Recommendations, and Improvement Potentials

- The environmental profile is dominated by the **AIT phase, Equipment manufacturing phase and the Staff labour hours**.
- The most critical environmental hotspot is the category “Resource use, fossil”, that is mainly driven by **energy consumption** in the form of electricity.
- The second most critical environmental hotspot is impact category “Ecotoxicity, freshwater”, which impact is driven by the extraction of the metals used as primary materials in the **electronic components**.

Ecodesign recommendations

- Mass optimization of the electronic components
- Optimization of industrial operations, including facilities

Methodological improvements

- Focus the data collection of primary data on mission specific elements
- Evolve the ECSS documentation standards to include data relevant from an LCA perspective

Questions?