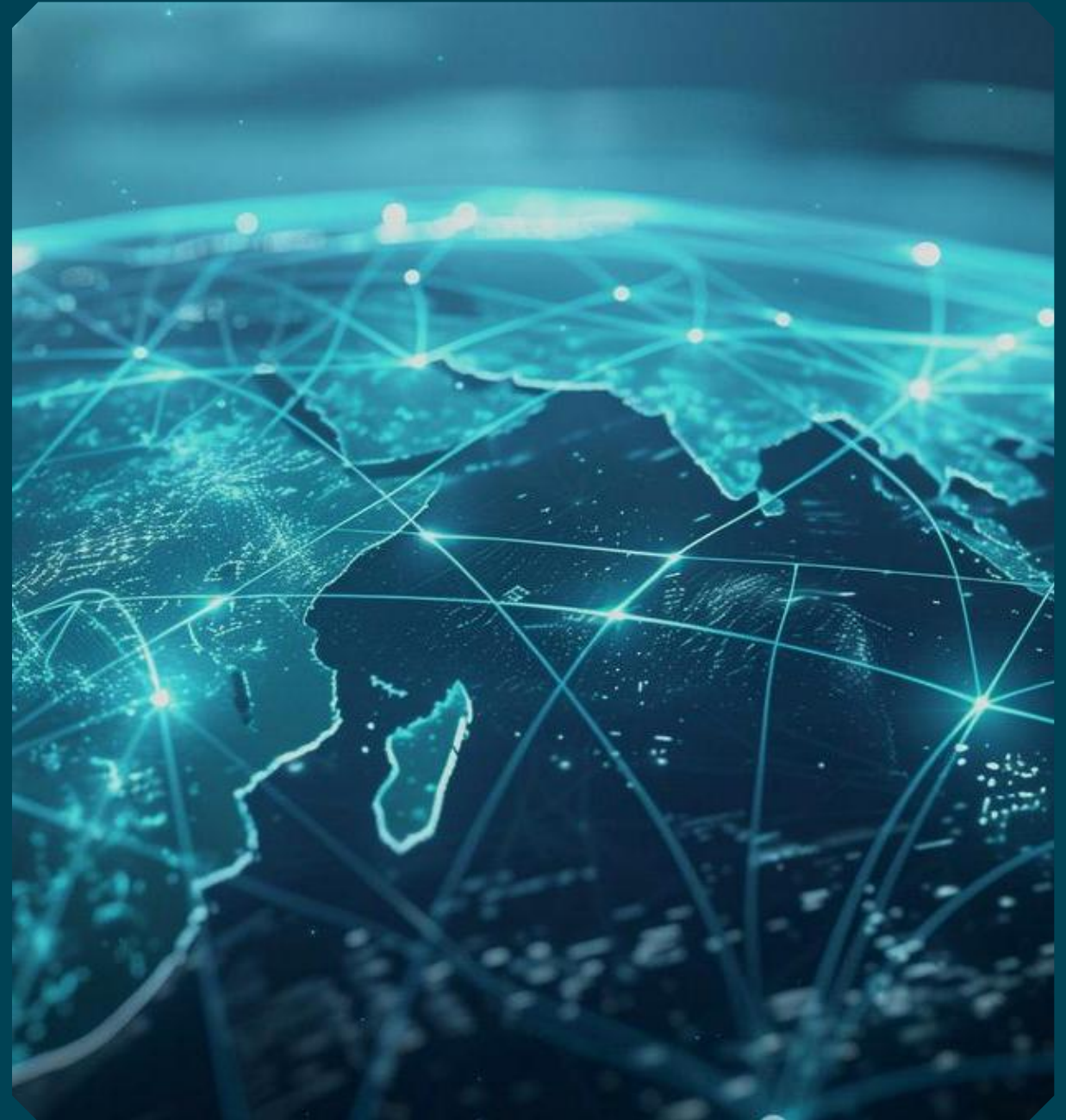


# ECOSAT

Ecostar Phase 0 - LCA Results and lessons learned applied to a platform baseline design for a constellation



**Indra Space**



# Introduction

# Single satellite vs Industrialized

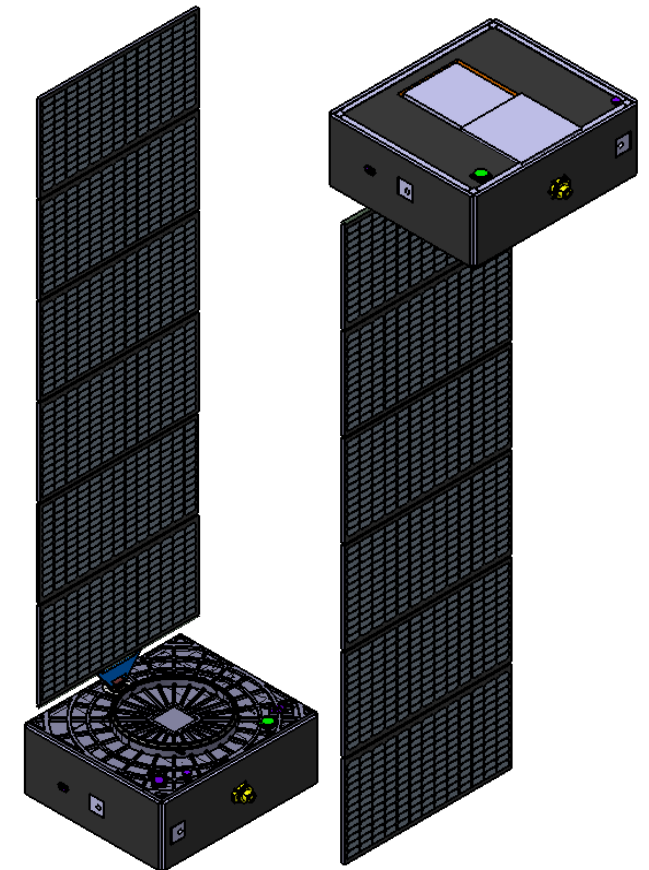
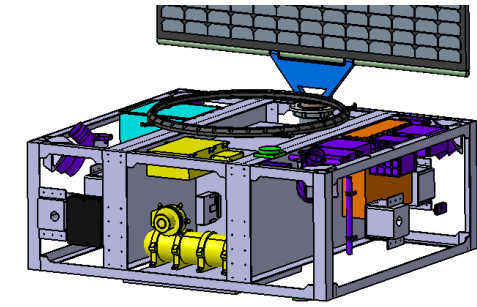


# Single satellite vs **Industrialized**

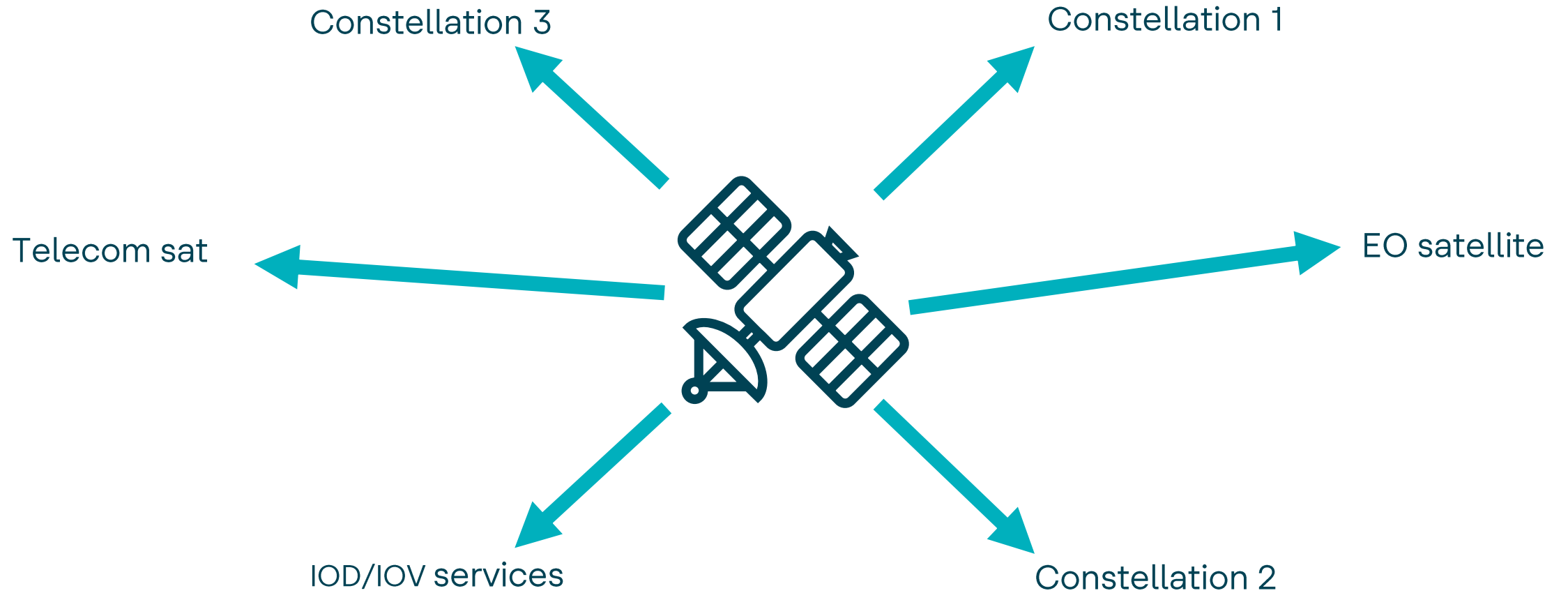


# Powerbook

- Deimos **PowerBook** Preliminary Design
  - Multipurpose constellation platform
  - High aspect ratio
  - 100 to 200 kg Platform
  - High Performance Design
    - S-Band Transceiver & Antenna architecture
    - Optical Inter-Satellite Link Transceivers
    - Deimos' existing READY-200 ADCS product
    - Propulsion for orbit manoeuvrability
    - High power capacity



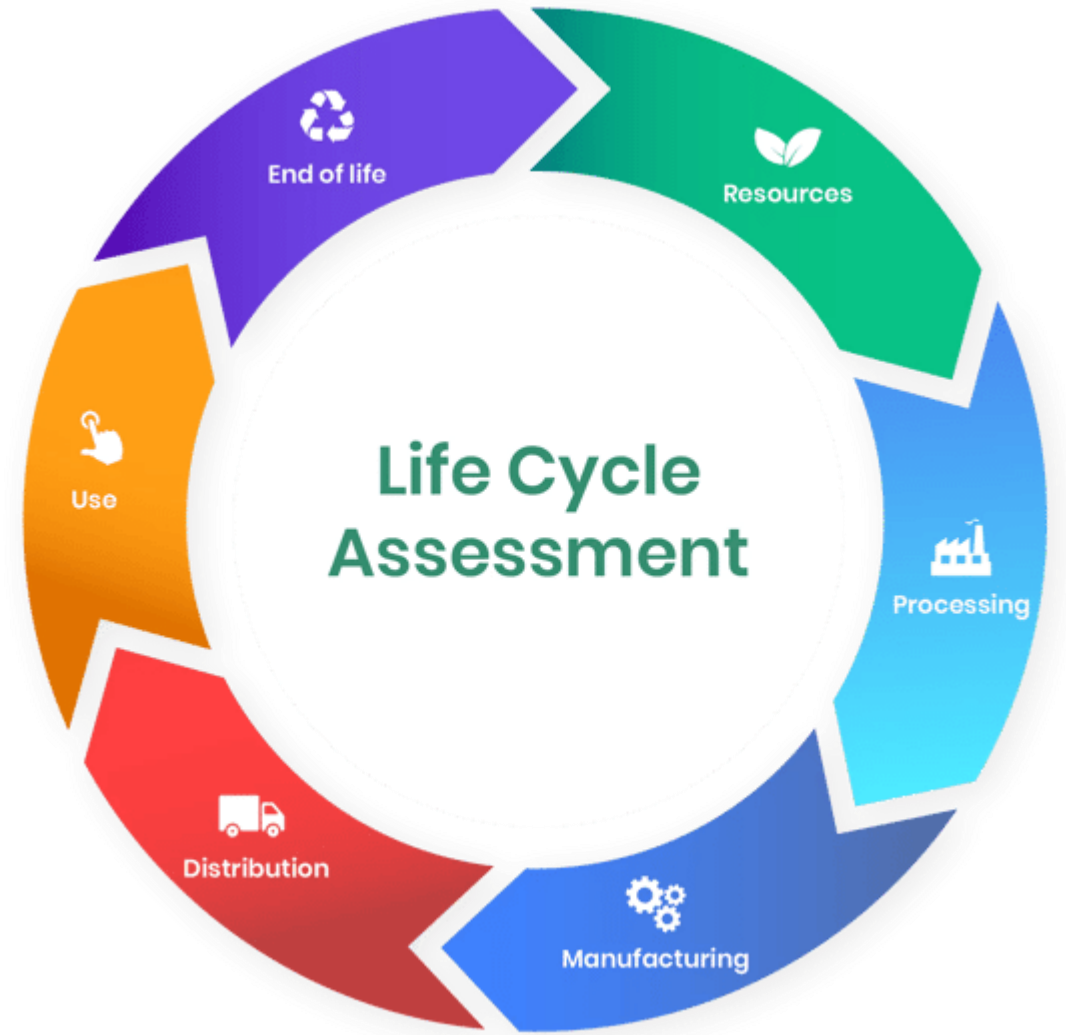
# Powerbook



# Challenges ecodesign



# Challenges ecodesign



# Challenges in ECOSAT



Lack of  
information



Limited  
Time



Multiple  
approach



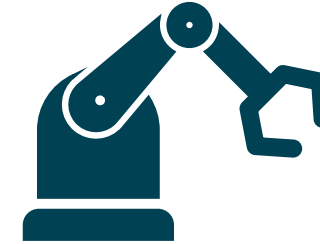
Concurrent  
development

# Multiple approach

Model philosophy



Industrialization



Structure optimization

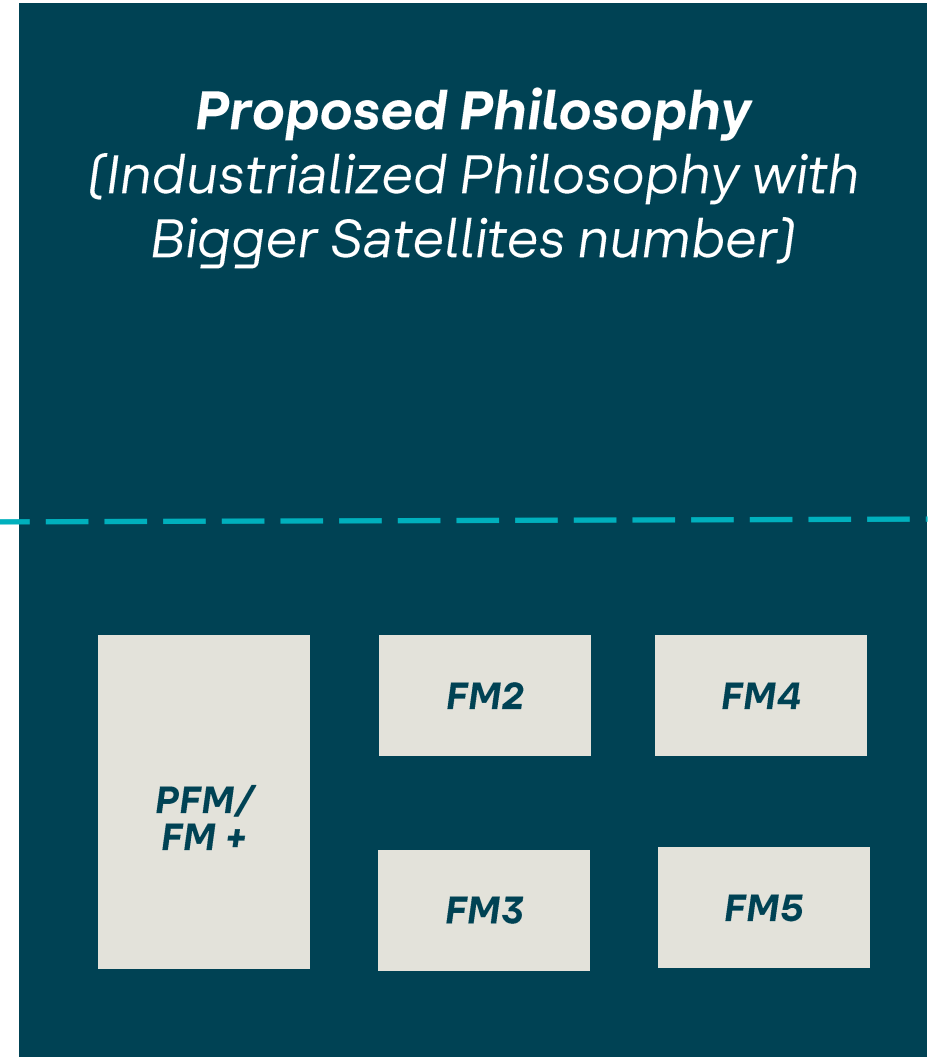
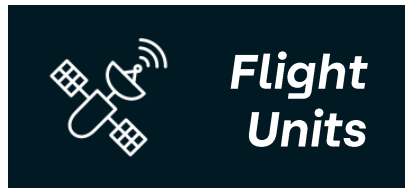
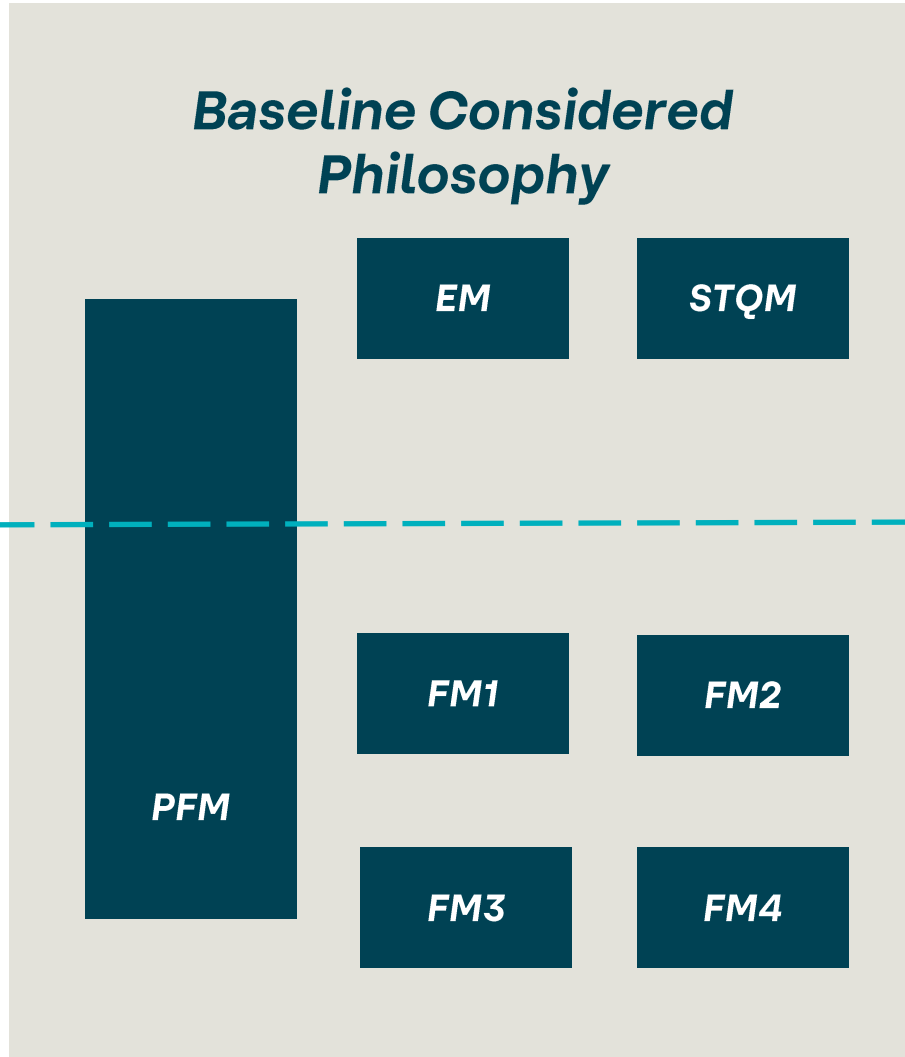


Manufacturing methodologies



# Optimizations

# 1. Model Philosophy



## 2. Industrialization

***Smart Production  
& Practices***

***Smart Factory and Manufacturing Control***

***Improved Economies of Scale***

***Improved Logistics (Transport, Time)***

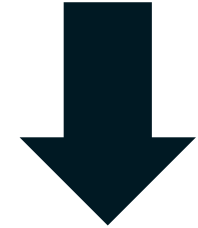
***Improved Packaging Logistics***

***GSE Reduction / Reusability***

Clean room  
time



Waste

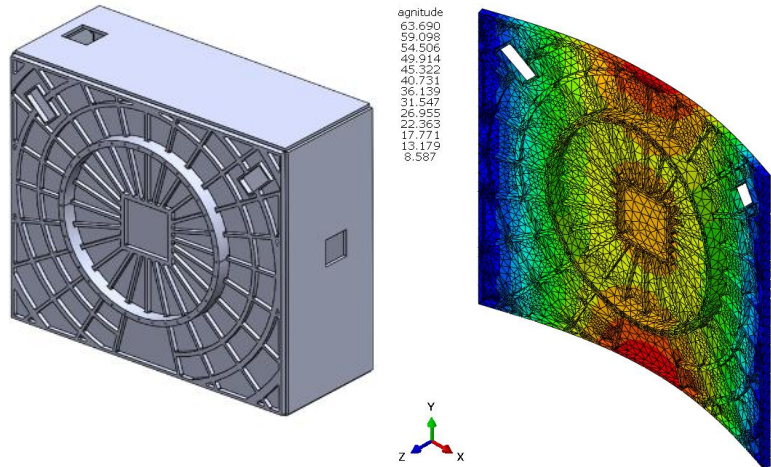


Efficient  
processes

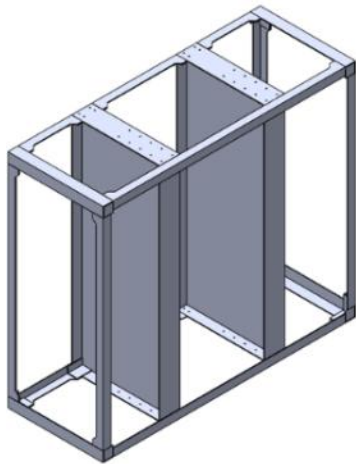
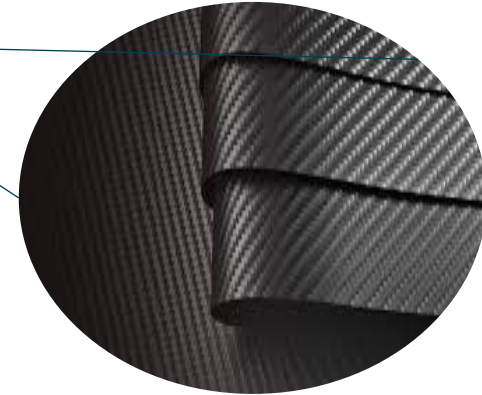
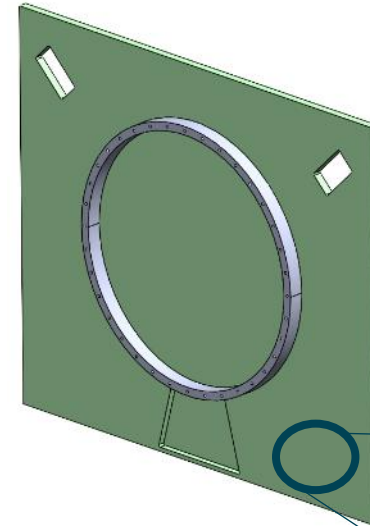


GSE  
reutilization

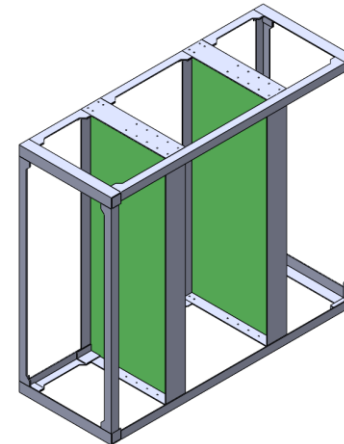
# 3. Structure Optimization



40% mass reduction



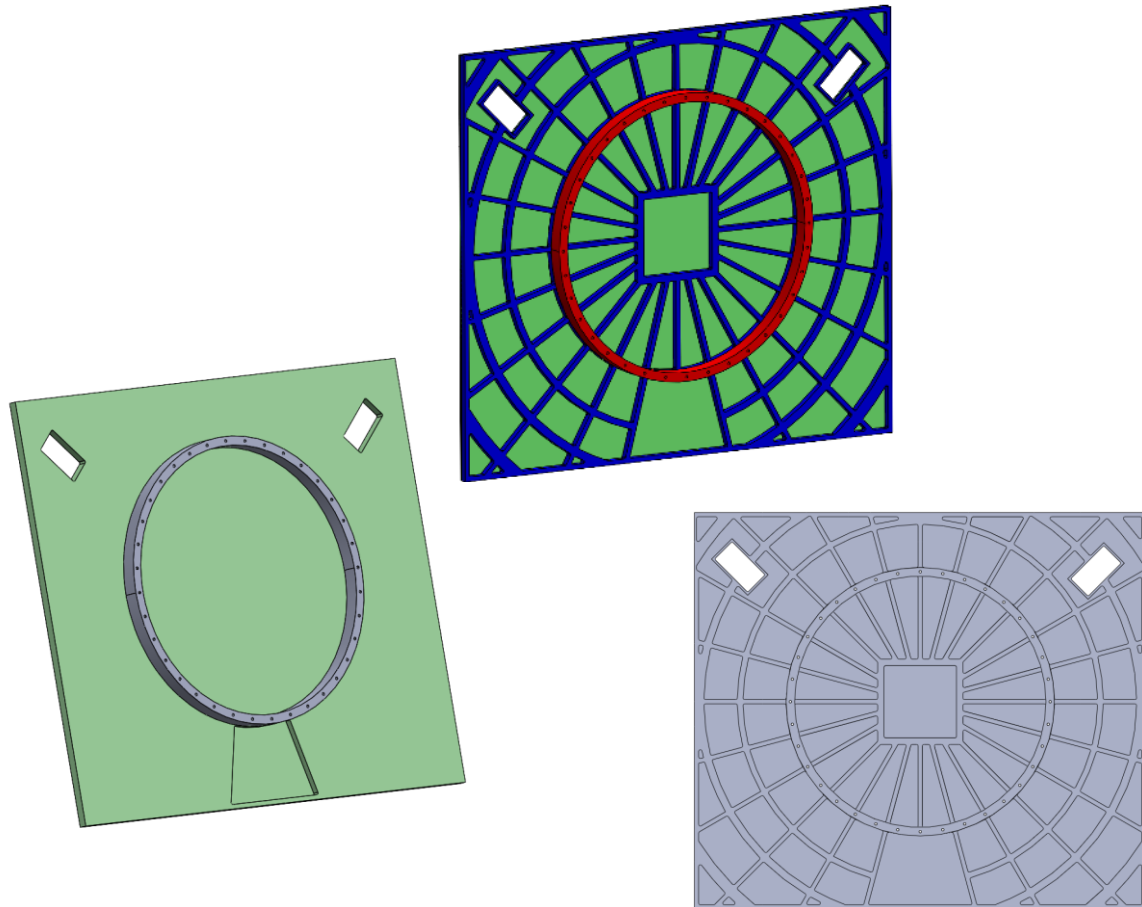
43% mass reduction  
(plate only)



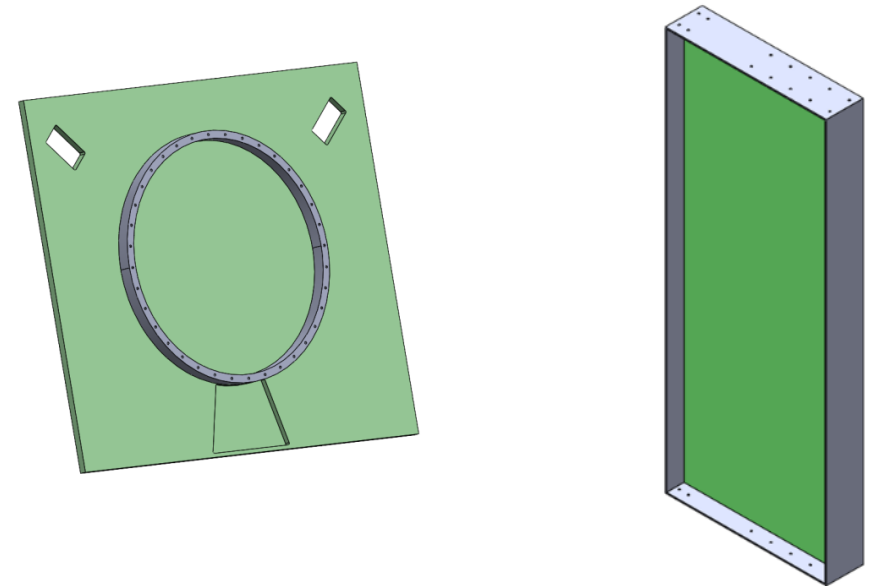
**28% mass reduction in  
the first stage of  
redesign**

# 4. Manufacturing methodologies

## Aluminium Improved Manufacturing Steps



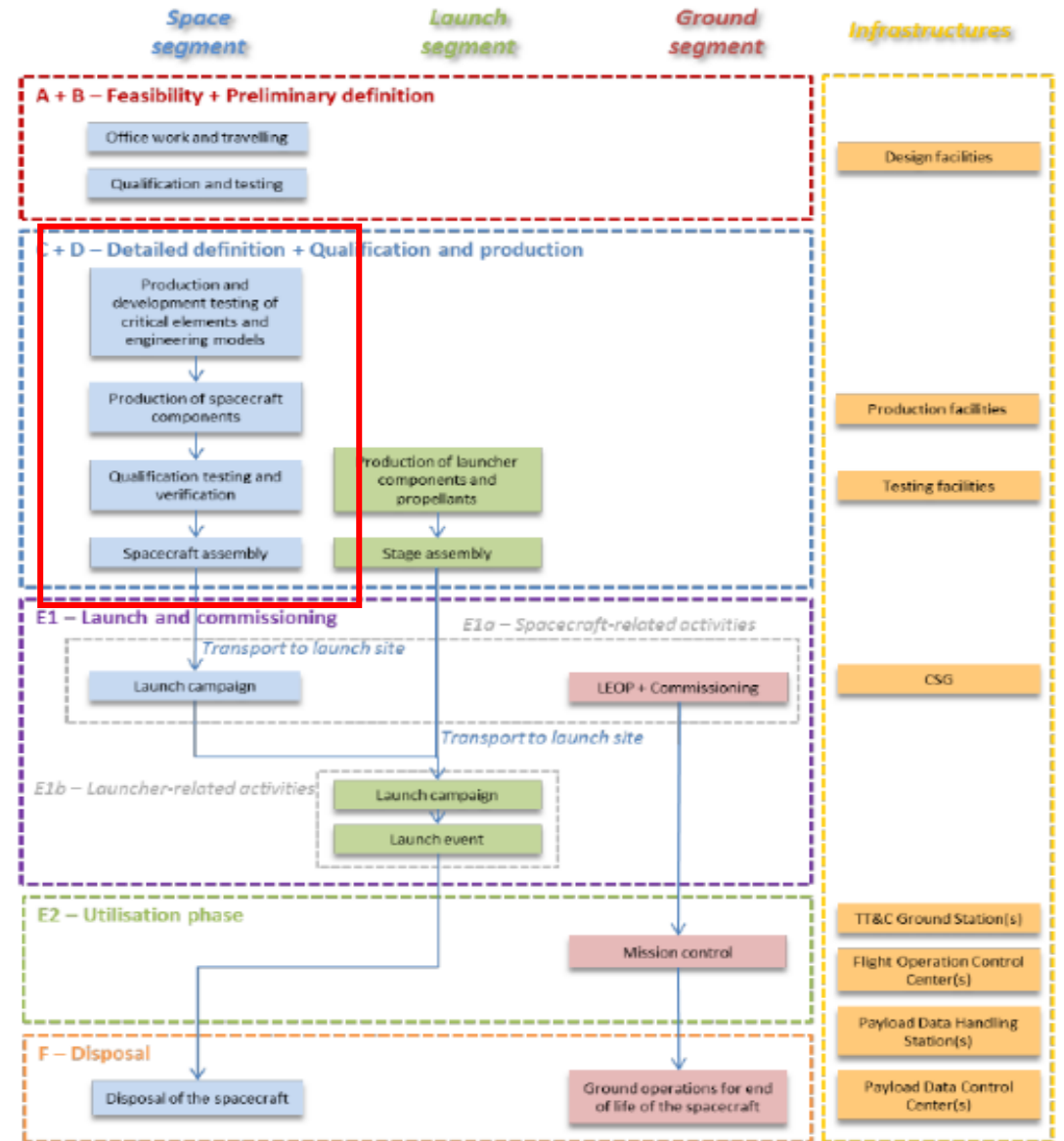
## Composite Manufacturing Steps



# LCA for baseline satellite

# Functional unit

- LCA based on functional unit: “One space mission in fulfilment of its requirements”
- Deployment of an air traffic management constellation [5 sats]
- Baseline:
  - 1xEM
  - 1xSTQM
  - 1xPFM
  - 4xFM

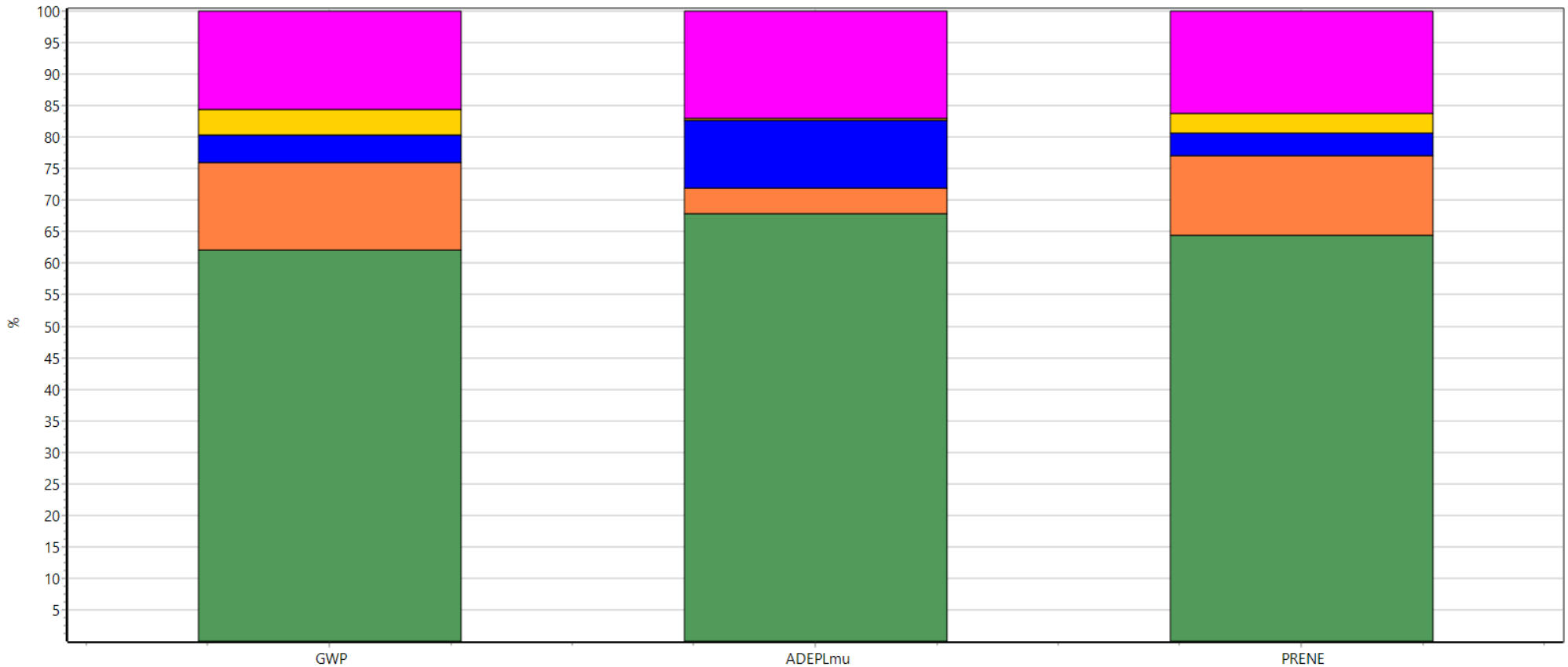


# Results – Model Philosophy, Real Scenario

- FM Full System
- GSE full System
- EM Full System
- STQM Full System
- PFM Full System

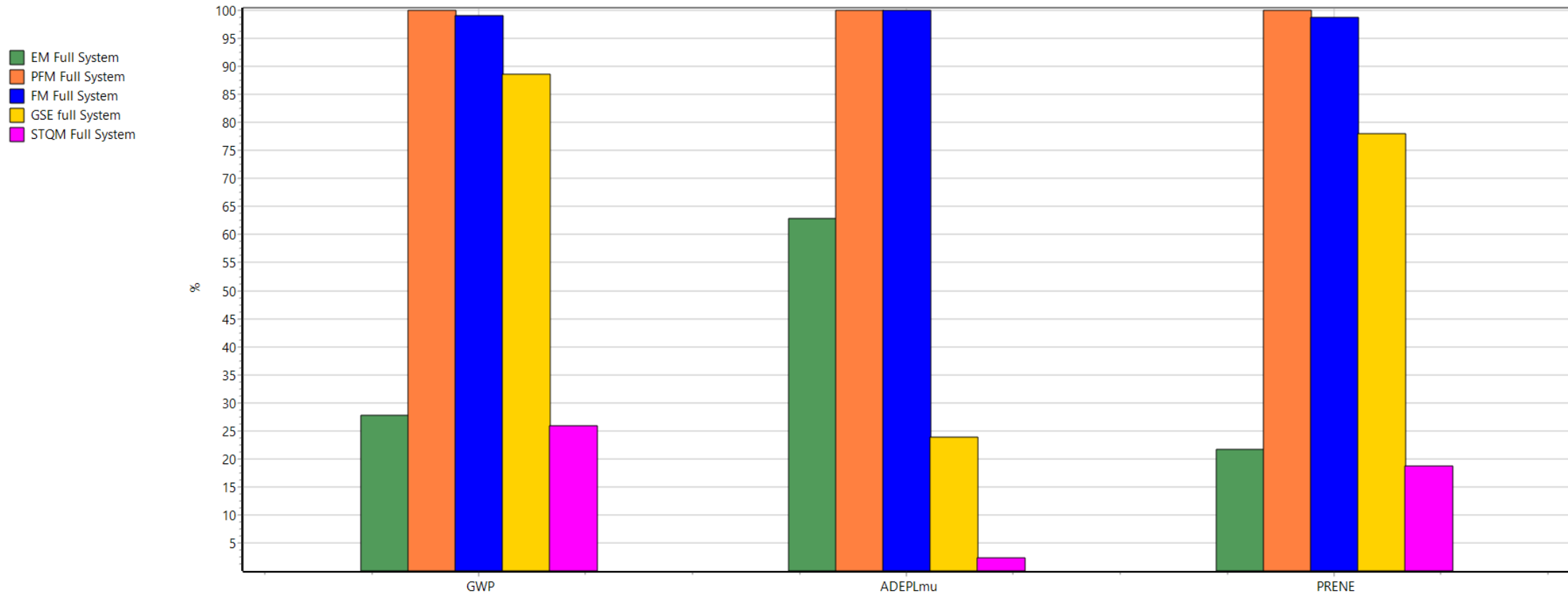
**Real model philosophy:**

- FM = x4
- STQM = x1
- PFM = x1
- EM = x1



Method: ESA LCIA - EF 3.0 Method (adapted) V1.03 / EF 3.0 normalization and weighting set / Characterization  
 Analyzing 1 p 'Powerbook full System';

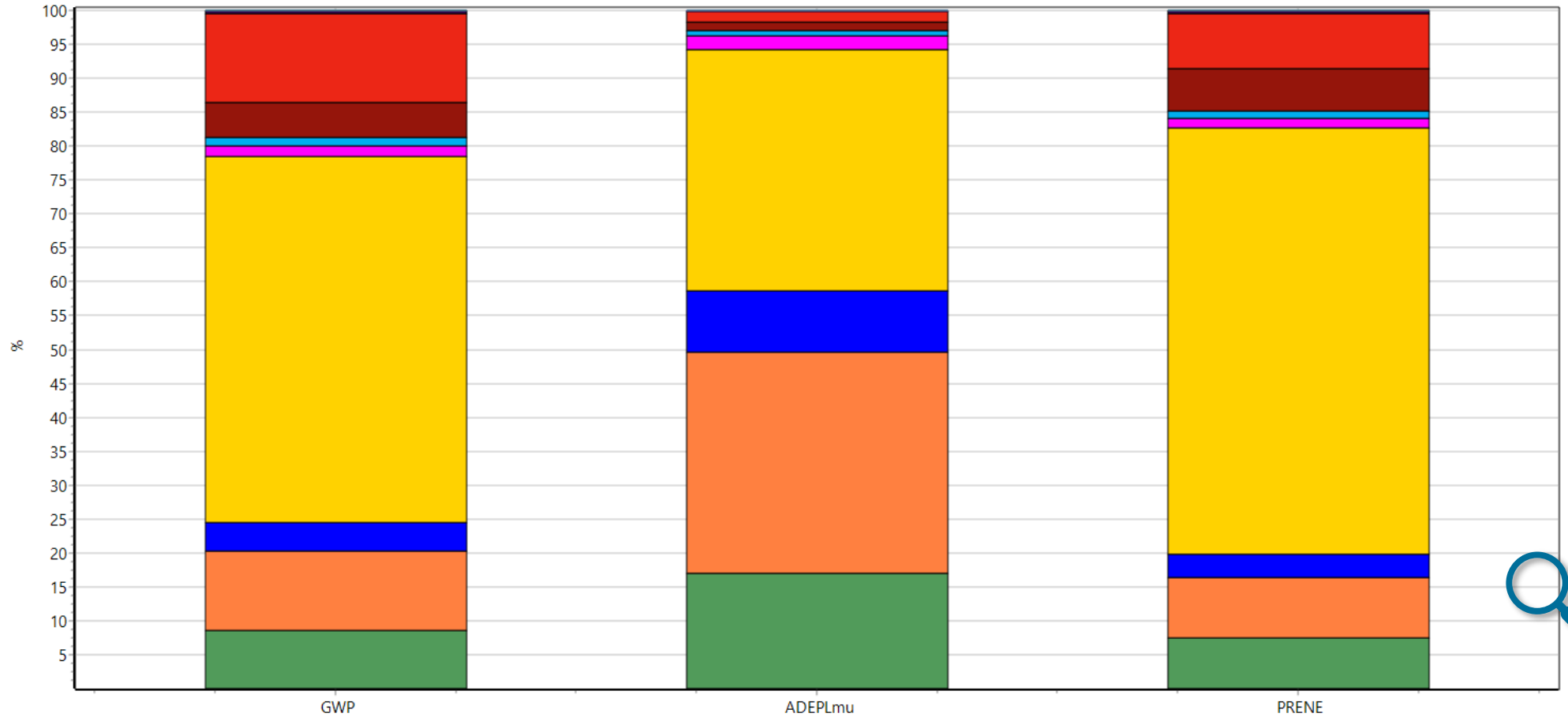
# Results – Model Philosophy, One-to-One Comparison



Method: ESA LCIA - EF 3.0 Method (adapted) V1.03 / EF 3.0 normalization and weighting set / Characterization  
Comparing product stages;

# Results - FM, Full system

- ADCS, FM
- CDHS, FM
- COMMS, FM
- EPS, FM
- Harness, FM
- Payload, FM
- Propulsion Subsystem, FM
- Structure, FM
- TCS, FM
- FM Full System, Transport
- FM Full System, Testing
- FM Full System, Staff travel
- FM Full System, Staff office work
- FM Full System, Raw materials & LLI
- FM Full System, Processes
- FM Full System, Clean Room



Method: ESA LCIA - EF 3.0 Method (adapted) V1.03 / EF 3.0 normalization and weighting set / Characterization  
 Analyzing 1 p 'FM Full System';

# Insights

- **Half of FM impacts** are associated with **Solar Array** (Ge wafer value chain)
- **STRU accounts for almost 20%** of total impacts for FM
- Main contributions are **raw materials (e.g. metals)**, accounting for quite 90% of total impacts
- When present, **electronics (e.g. PCB, IC)** are impacting (e.g. Au value chain)
- Production processes (e.g. machining) do not overcome 10%
- Working on **waste reduction** will significantly help the reduction of raw materials impacts
- **GSE re-usability** could also reflect in a reduction of global impacts
- **Testing, Clean Room and Transport** impacts are **almost negligible**
- Review assumptions that affect results not expected

# Insights

- **Half of FM impacts** are associated with **Solar Array** (Ge wafer value chain)
- **STRU accounts for almost 20%** of total impacts for FM
- Main contributions are **raw materials (e.g. metals)**, accounting for quite 90% of total impacts
- When present, **electronics (e.g. PCB, IC)** are impacting (e.g. Au value chain)
- Production processes (e.g. machining) do not overcome 10%
- Working on **waste reduction** will significantly help the reduction of raw materials impacts
- **GSE re-usability** could also reflect in a reduction of global impacts
- **Testing, Clean Room and Transport** impacts are **almost negligible**
- Review assumptions that affect results not expected

Structure Optimization

Production method

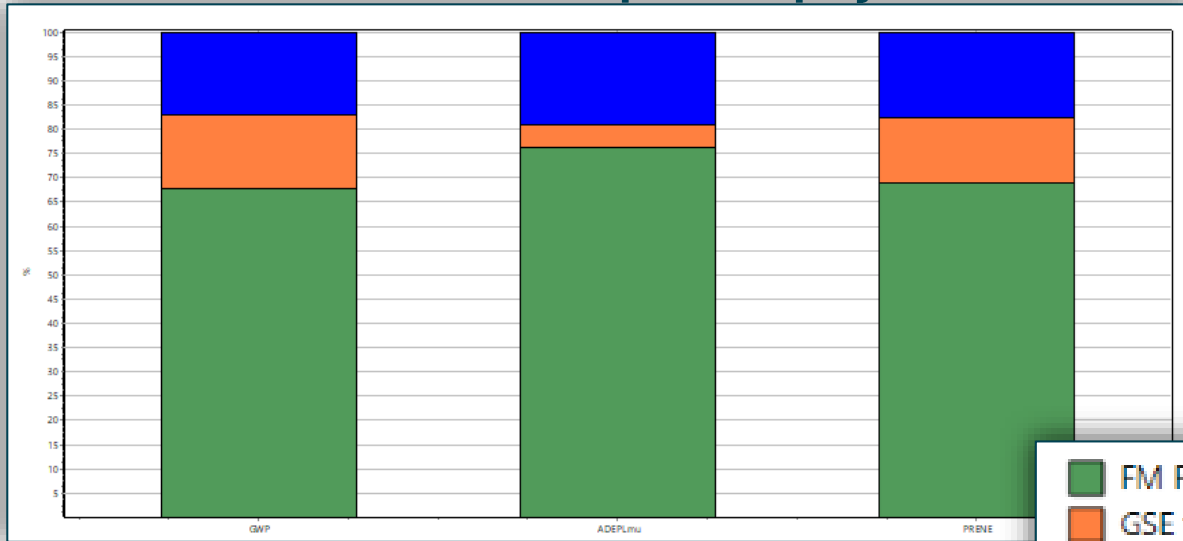
Industrialization

Model philosophy

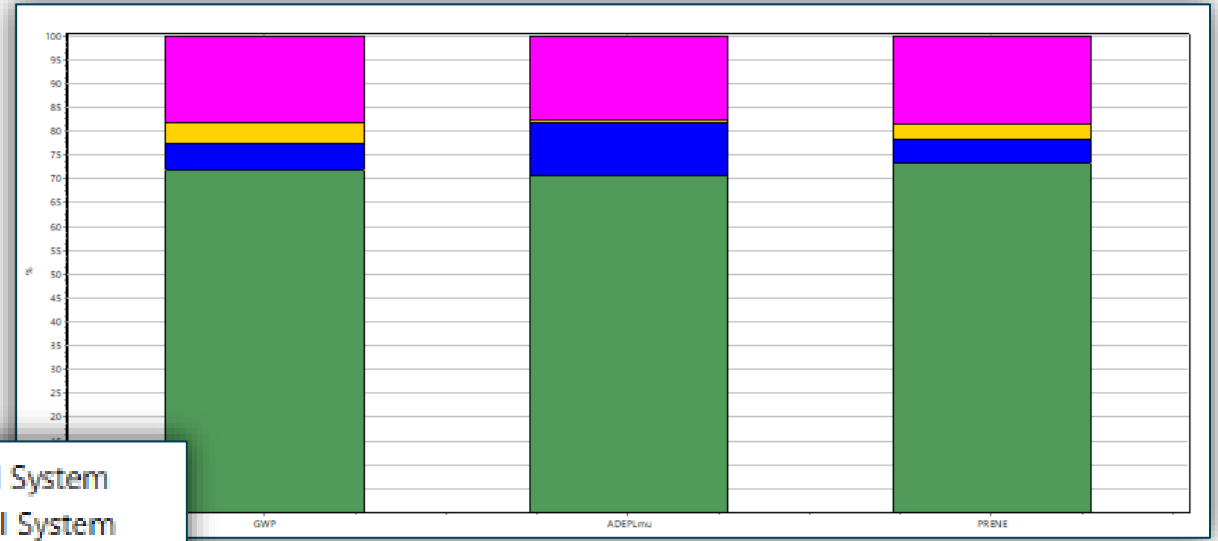
# LCA for ECOSAT solutions

# LCA for Optimized solutions

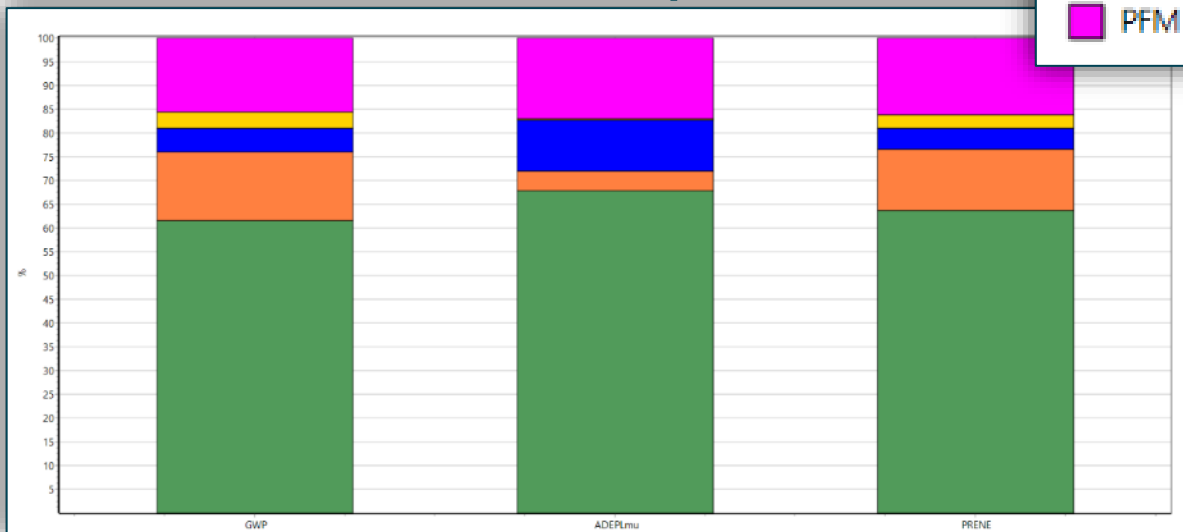
## 1. Model philosophy



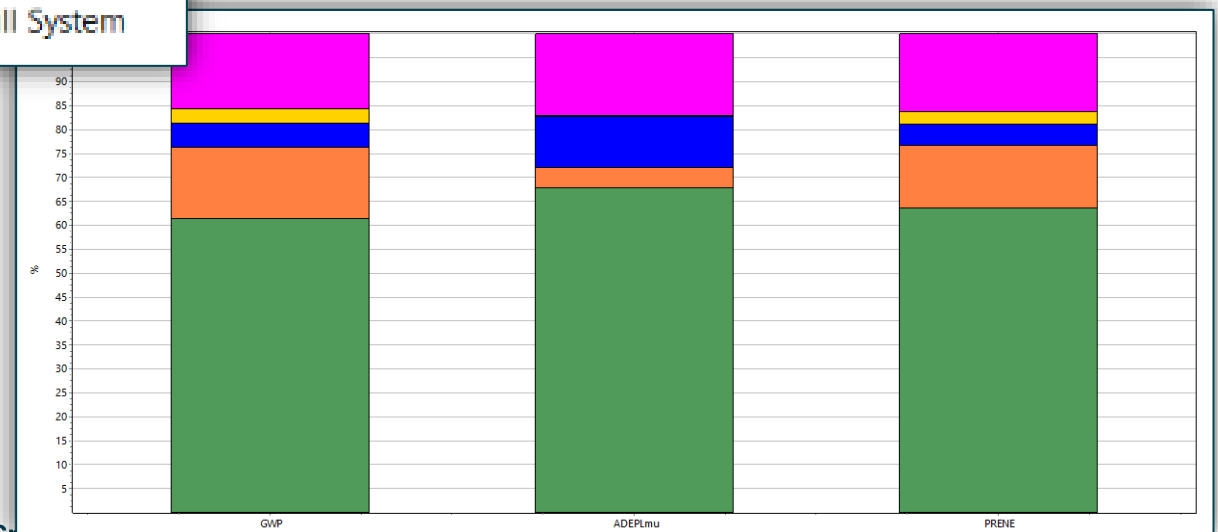
## 2. Industrialization



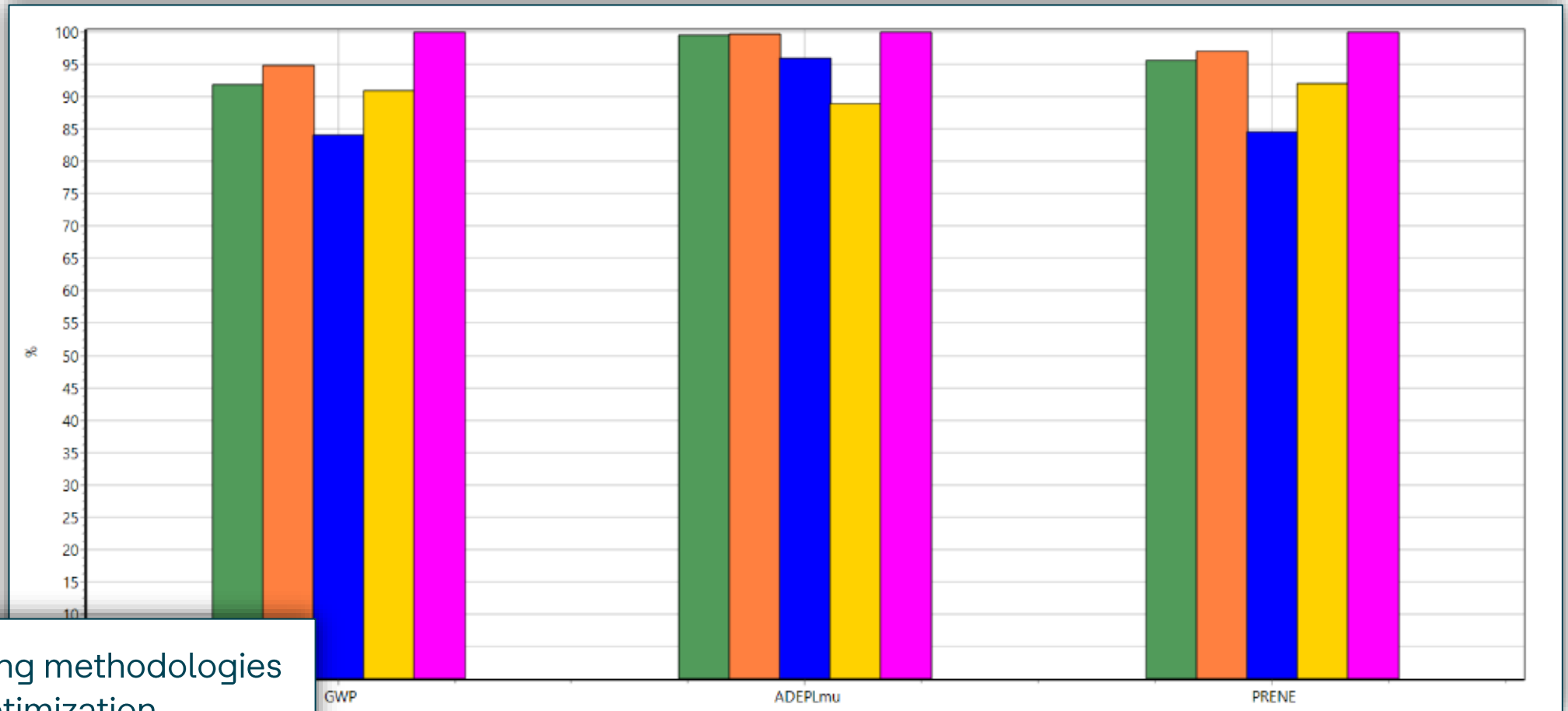
## 3. Structural optimization



## 4. Manufacturing methodologies

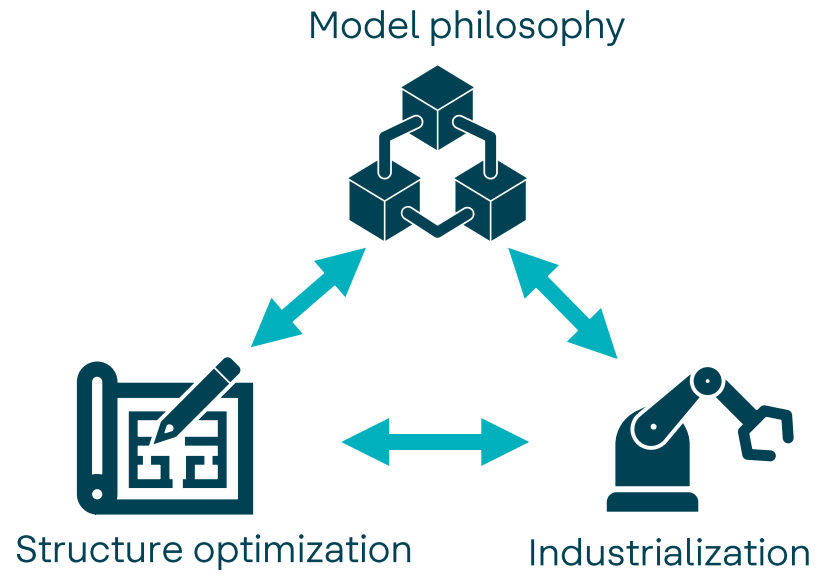


# LCA for Optimized solutions

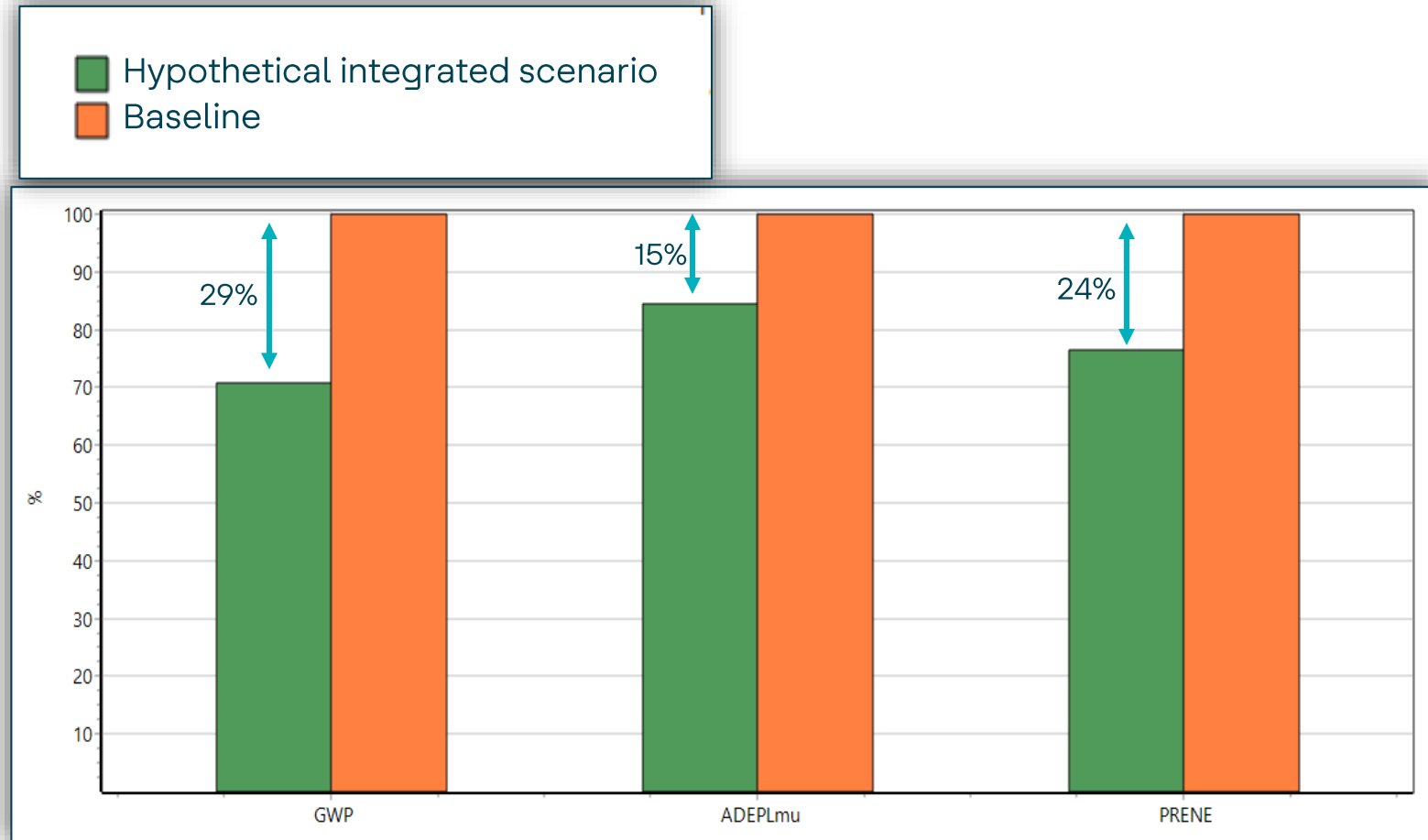
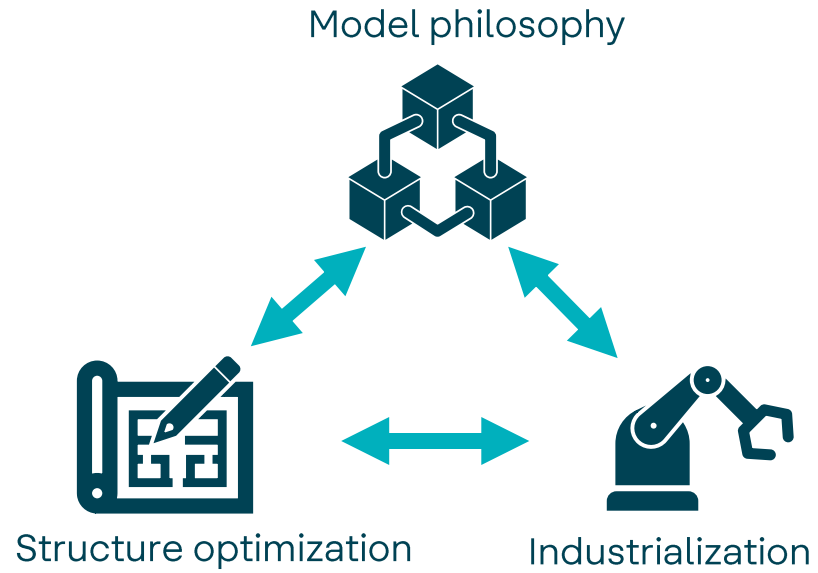


- Manufacturing methodologies
- Structure optimization
- Industrialization
- Model philosophy
- Baseline

# Integrated scenario



# Integrated scenario



# Key Findings

# Key Findings

- **At mission level**, the most benefit could be achieved through the **reduction and reuse of non-flight units** (i.e. GSE, STQM, EM).
- **At Flight Model level, Subsystem-level interventions** (e.g. material changes, scrap reduction) deliver the most significant impact reduction. This improvements scale directly with the number of satellites
- Most of the environmental impacts are **related to material use/production** so improvements on processes (clean room, testing, transportation...) have a smaller effect.
- ECOSAT will aim to address different sizes of missions so future work shall aim to **optimize ground infrastructure/activities as well as satellite design**
- A **combined optimization scenario** improves ECOSAT's environmental profile and meet **most project sustainability targets**.
- Future steps should also consider **space sustainability and zero debris**



# Thanks

Contact:

[mzarcod@indra.es](mailto:mzarcod@indra.es)

[jbilbaod@indra.es](mailto:jbilbaod@indra.es)