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GRIDDED ION ENGINE STANDARDISED ELECTRIC PROPULSION PLATFORMS GIESEPP

EPIC Workshop, 21 October 2019

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CONTENT

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01

OBJECTIVES AND EXPECTED IMPACT

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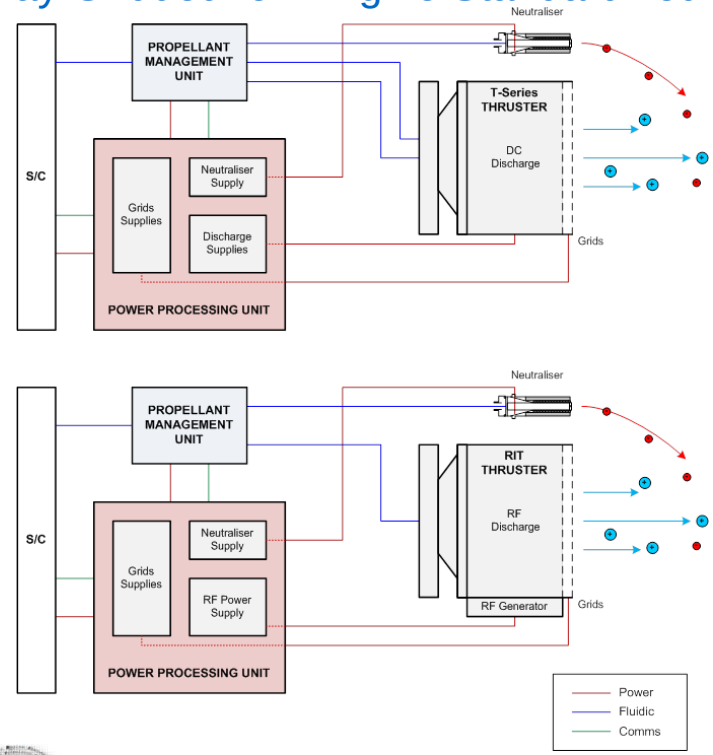
GIESEPP – OBJECTIVES (1/2)

Develop, build and test the first European Plug and Play **G**ridded **I**on **E**ngine **S**tandardized **E**lectric **P**ropulsion **P**latforms (**GIESEPP**) including

- Gridded Ion Engines (GIE),
  both from ArianeGroup and QinetiQ Space,
- Propellant Management System (XPMS),
- Power Processing Unit (PPU),

to meet the future needs of the

- GEO Telecoms, Navigation
- LEO & Constellation markets
- Space Transportation, Exploration and Interplanetary Missions, OOS



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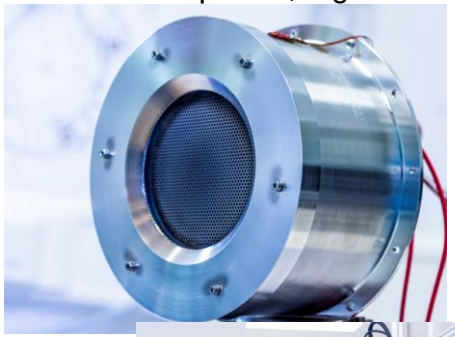
GIESEPP – OBJECTIVES (2/2)

In particular our aims are

- Worldwide **technology leadership in the fields of high ISP electric propulsion** by incremental development, e.g.
  - Dual mode functionality (EOR – SK)
  - Modular and multifunctional PPU (Power Processing Unit)
  - Miniaturized propellant management system
- Maintaining and securing **European non-dependence**
- Ensuring **competition and risk mitigation** through modularity and interchangeability
- Solid **competitiveness** through significant **reduction of the EPS cost** by 30+% by
  - Maximized **mass reduction** on EPS level
  - Foster **industrialization** to fast and in-time mass-production
  - **Standardization** of testing sequences and methods for significant
  - Maximize **commonality** on equipment, interfaces and components
  - **Sourcing asset** by common batch procurement and maximized OTS use and non-single sourcing
- Assess and select an **alternative (cheaper) propellant**



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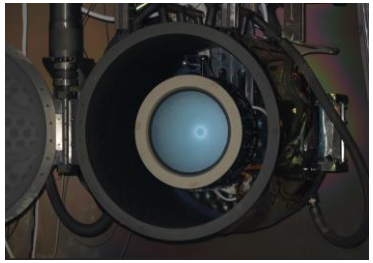
GIESEPP - IMPACT AND AMBITION

Ambition:

- Create first ***standardised all European*** cost and commercial competitive EPS – ITAR-free
- Improve ***European technological EP capabilities*** – GIE as strong pillar near HET, HEMPT et.al.
- Provide ***market solutions ready for sale*** with adequate production capabilities and processes
- Provide ***most economic EPS*** solution with both high thrust and high ISP in one product



Impact:

- Provide qualified OTS system by 2023 to be able to ***address worldwide highly competitive markets***
- Strengthened ***EP core competences***: system – thruster - propellant management - power processing to compete worldwide
- Propose ***most cost efficient EPS*** over lifetime: dual mode for high thrust and high ISP (while only ~3% of lifetime require high thrust)
- Faster production process by increased and ***optimised production capacities***, thus higher market availability
- Promoted ***EP diversity*** and stronger interaction between different technologies
- Enable customers ***use-as-is*** option though modular OTS approach with different thruster types to chose
- Consolidated ***procurement efficiency*** through appropriate sourcing activities and make-or-buy trade-offs
- Combine ***highest mass savings*** for platform integrators through highest ISP (half propellant, smaller tanks/lower pressure) while ***highest growth potential*** as best to cope with increasing platform power
- Robust design with high stability transiting from empiric verification to more predictive through improved ***performance models***
- Available and confirmed ***alternative propellant*** to ensure maximized flexibility

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CONSORTIUM AND COMPETENCIES

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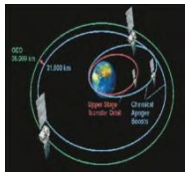
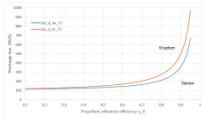
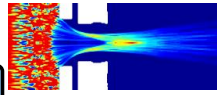
CONSORTIUM AND COMPETENCIES





Alternative Propellants
University of Southampton

Analytical Design and Test Support
Mars Space

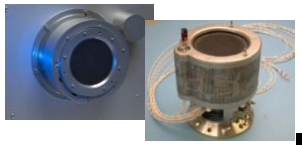


Satellite System Requirements
OHB

GIESEPP
Project Needs
and
Team Involvement

Testing
QinetiQ / ArianeGroup

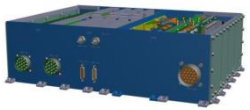
Thrusters
ArianeGroup / QinetiQ



Propellant Control
AST

System Engineering
ArianeGroup / QinetiQ

PPU
CRISA / Airbus DS



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GIESEPP CONCEPTS

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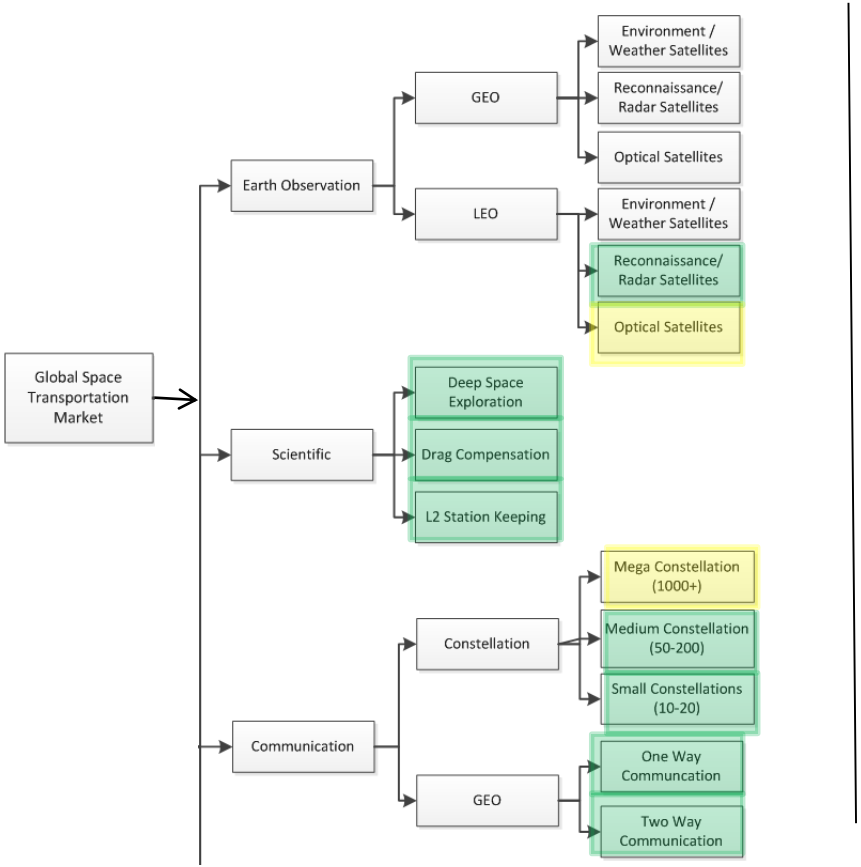
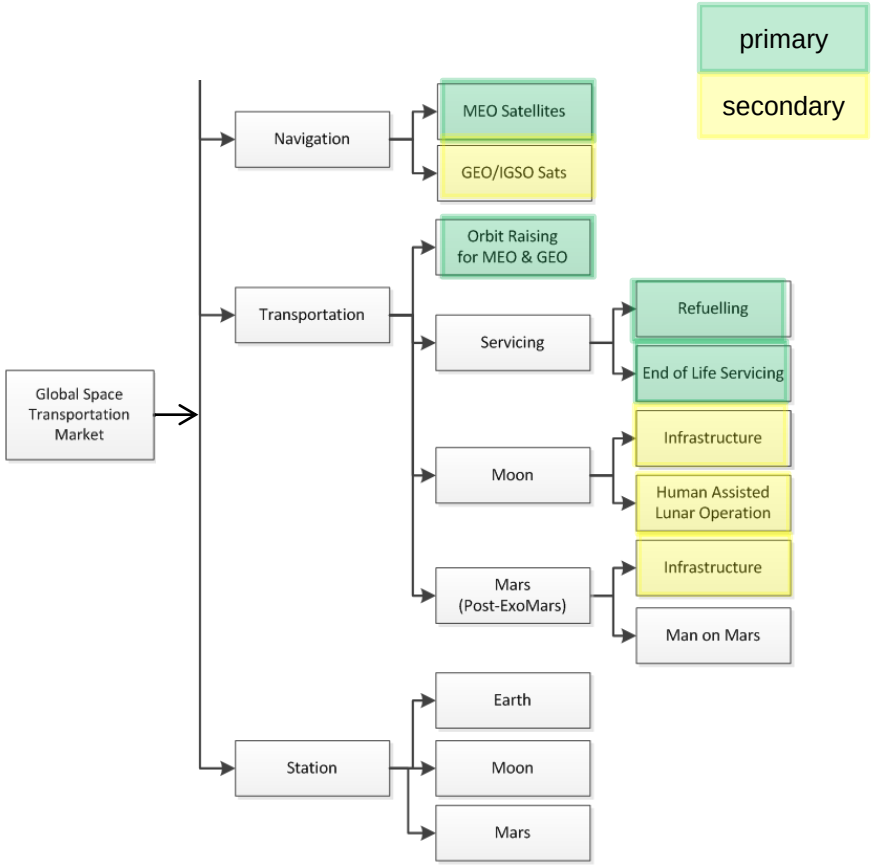
GIESEPP MISSION SCENARIOS





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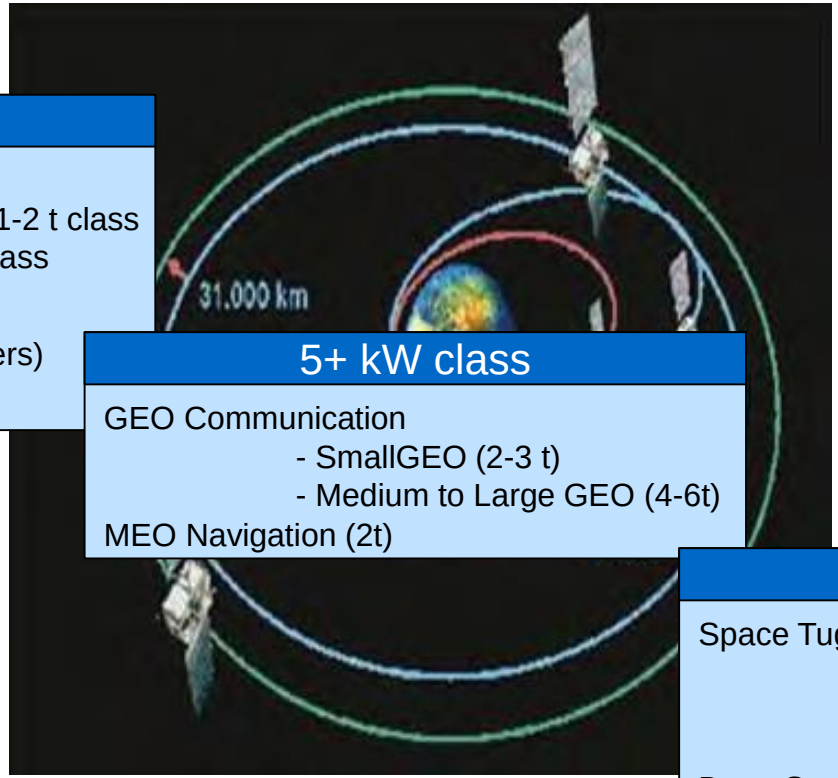
GIESEPP - CONSIDERED PLATFORMS



500+ W class

LEO Constellations
- Small/Medium – 1-2 t class
- Mega – 250 kg class

LEO EP Platform (500kg)

GEO Station Keeping (8 Thrusters)

In-orbit Servicing

5+ kW class

GEO Communication
- SmallGEO (2-3 t)
- Medium to Large GEO (4-6t)

MEO Navigation (2t)

20 kW class

Space Tug
- Navigation Sats
- GEO Sats
- Moon Station

Deep Space Exploration

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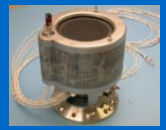
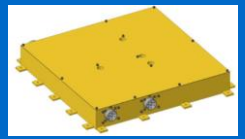
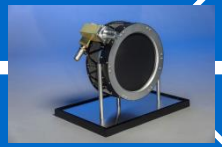
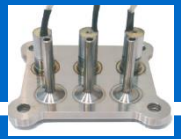
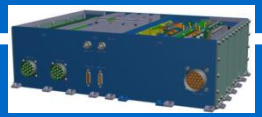
GIESEPP- PLATFORM MODULARITY

Thruster	Propellant Management	PPU	GIESEPP Platform
 or 	or  		LEO: 1L / 2L
 or  clustered			GEO/MEO: 1G
			Deep Space: 1S

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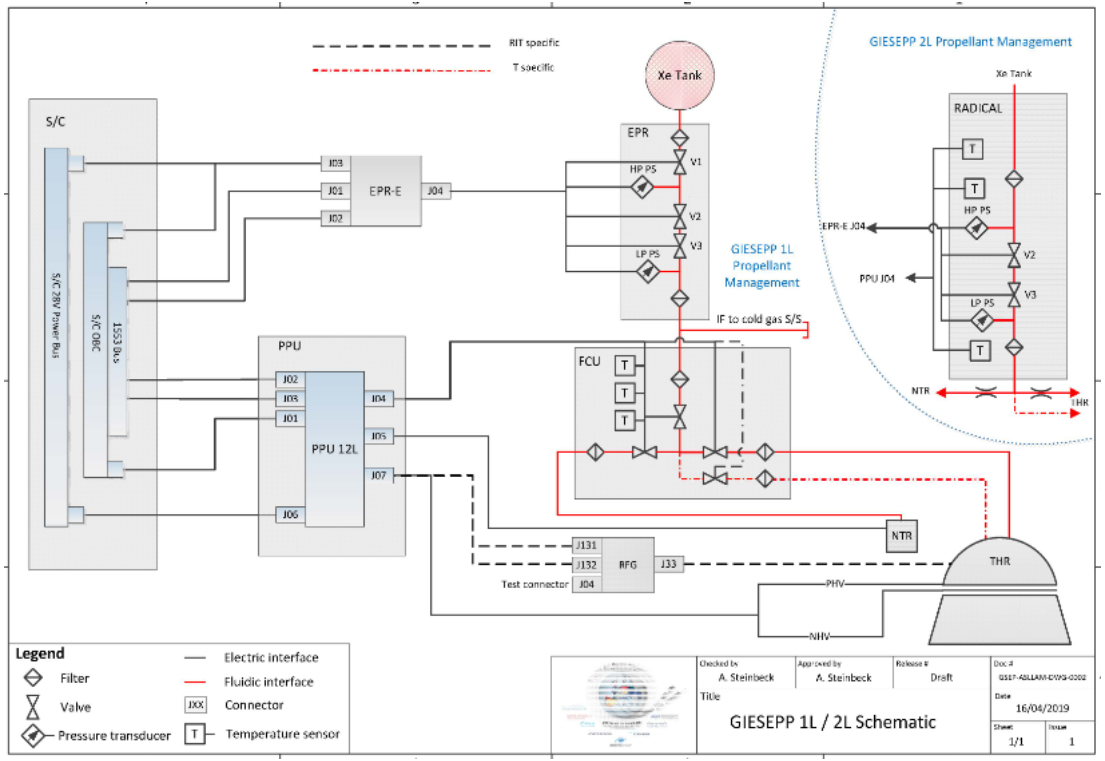
GIESEPP CONCEPT – GIESEPP 1L/2L – 200-700+ W - LEO

- ✓ 1 x Thruster Unite (incl. NTR)
- ✓ 1 x Power Processing Unit PPU 1L
- ✓ For 1L: 1 x Electronic Pressure Regulator EPR (+ option EPR-E)
- ✓ For 1L: 1 x Flow Control Unit FCU
- ✓ For 2L: 1x RADICAL instead of FCU and EPR
- ✓ 1 x set of Harness, Filters and Sensors



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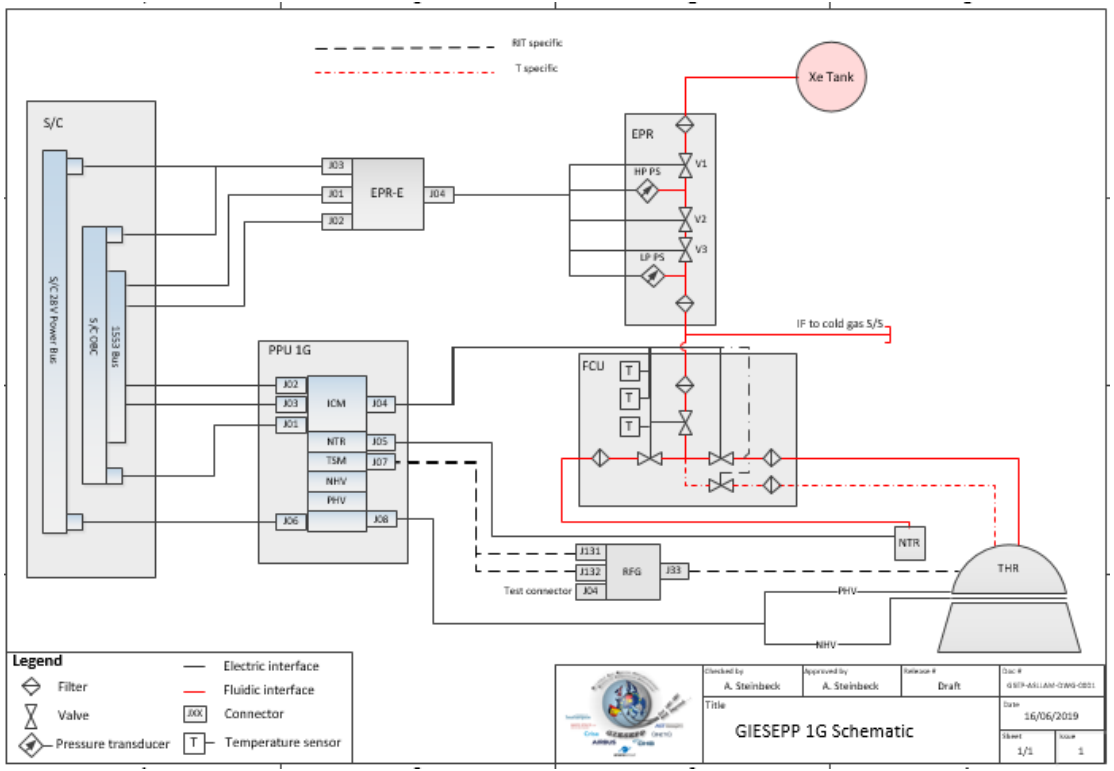
GIESEPP CONCEPT – GIESEPP 1G – 5KW – GEO/MEO

- ✓ 1 x Thruster Unit (incl. NTR)
- ✓ 1 x Power Processing Unit PPU 1G
- ✓ 1 x Electronic Pressure Regulator EPR (+ EPRE-E)
- ✓ 1 x Flow Control Units FCU
- ✓ 1 x set of Harness, Filters and Sensors



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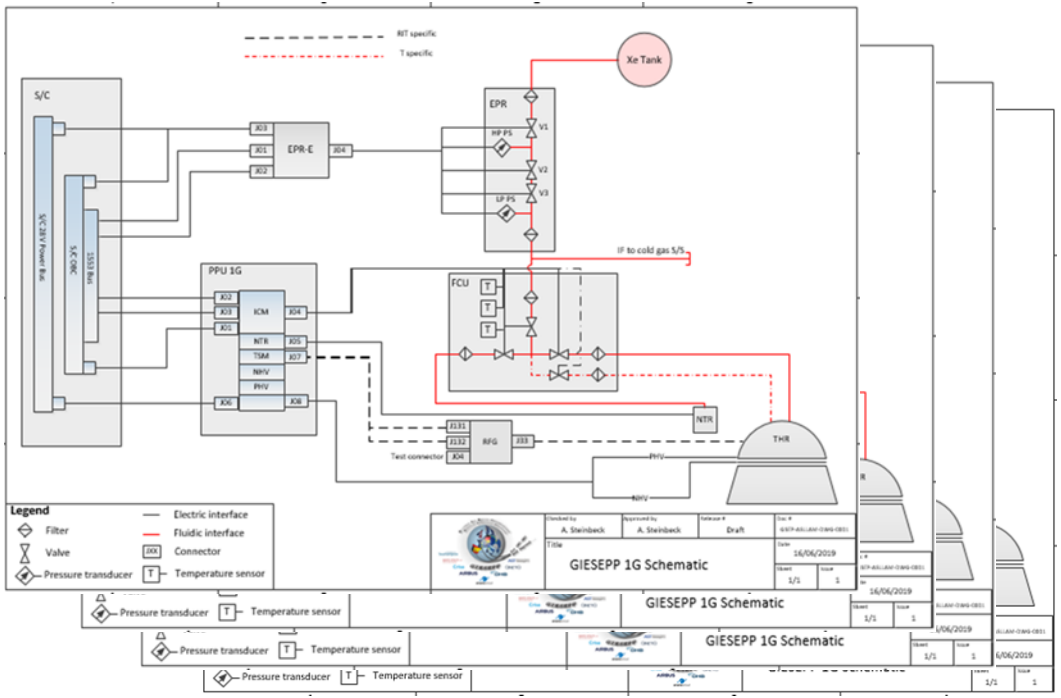
GIESEPP CONCEPT – GIESEPP 1G – 20KW – SPACE TRANSPORTATION, EXPLORATION AND INTERPLANETARY

Clustering of 4x GIESEPP 1G

- ✓ 4 x Thrusters
- ✓ 2-4 x Power Processing Unit PPU 1G
- ✓ 4 x Electronic Pressure Regulator
- ✓ 4 x Flow Control Units FCU
- ✓ 1 x set of Harness, Filters and Sensors



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ACTIVITIES AND SCHEDULE

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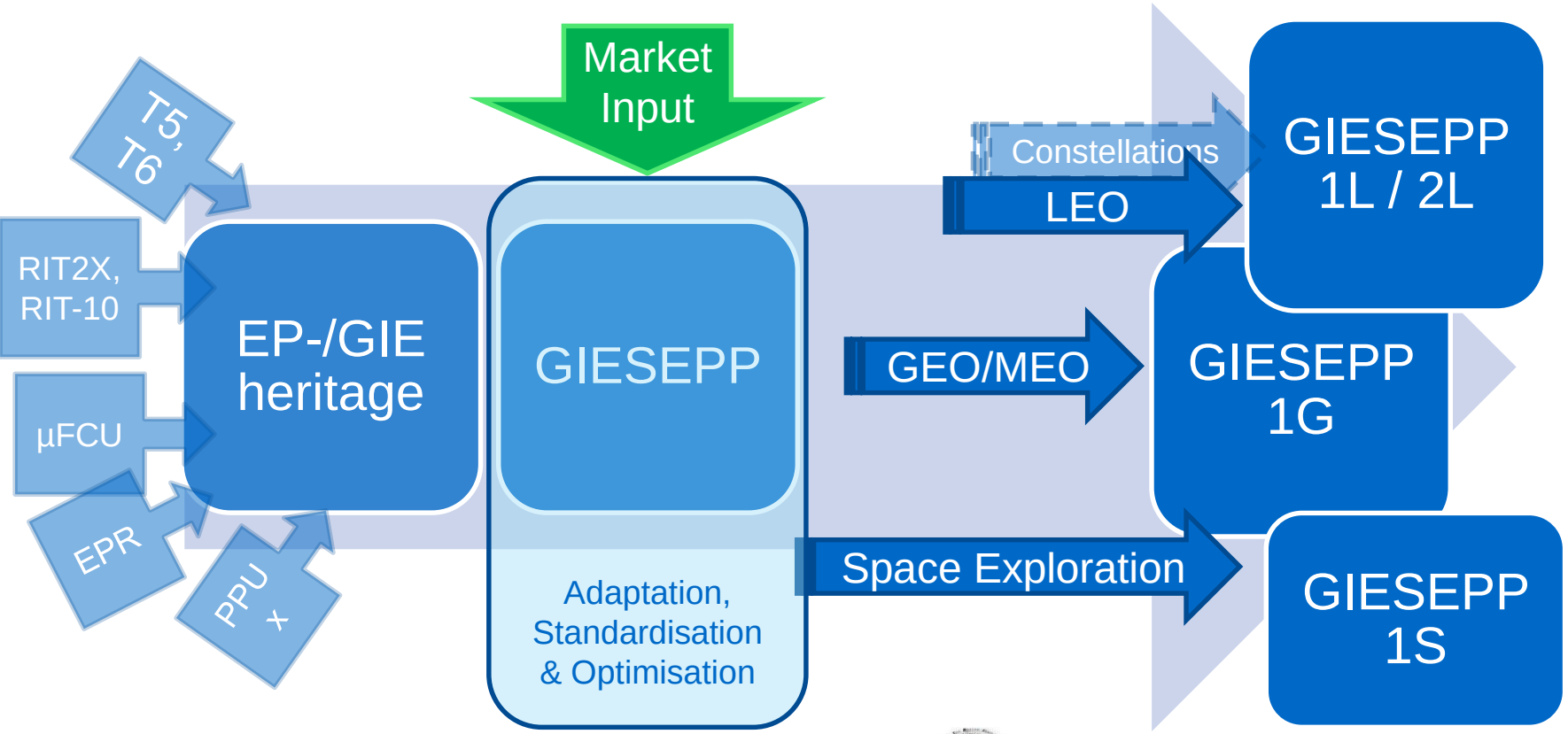
GIESEPP - ACTIVITIES AND SCHEDULE (1/3)



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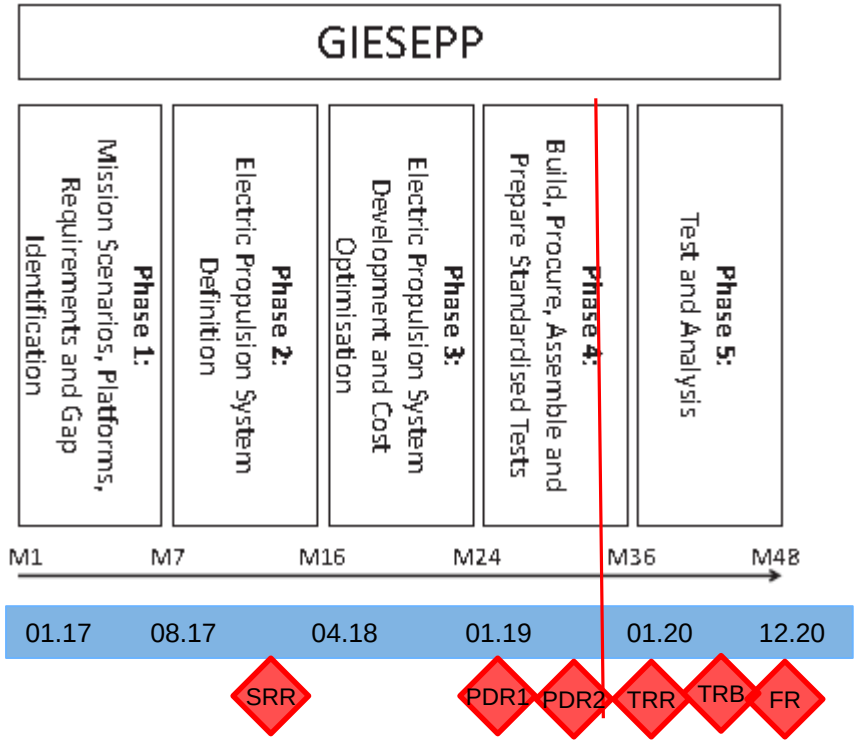
GIESEPP - ACTIVITIES AND SCHEDULE (2/3)

Current Status:

- ✓ PDR1&2 passed
- ✓ KP3 Final mission parameter defined
- ✓ Design adaptations under finalization
- ✓ Preparation of coupling tests



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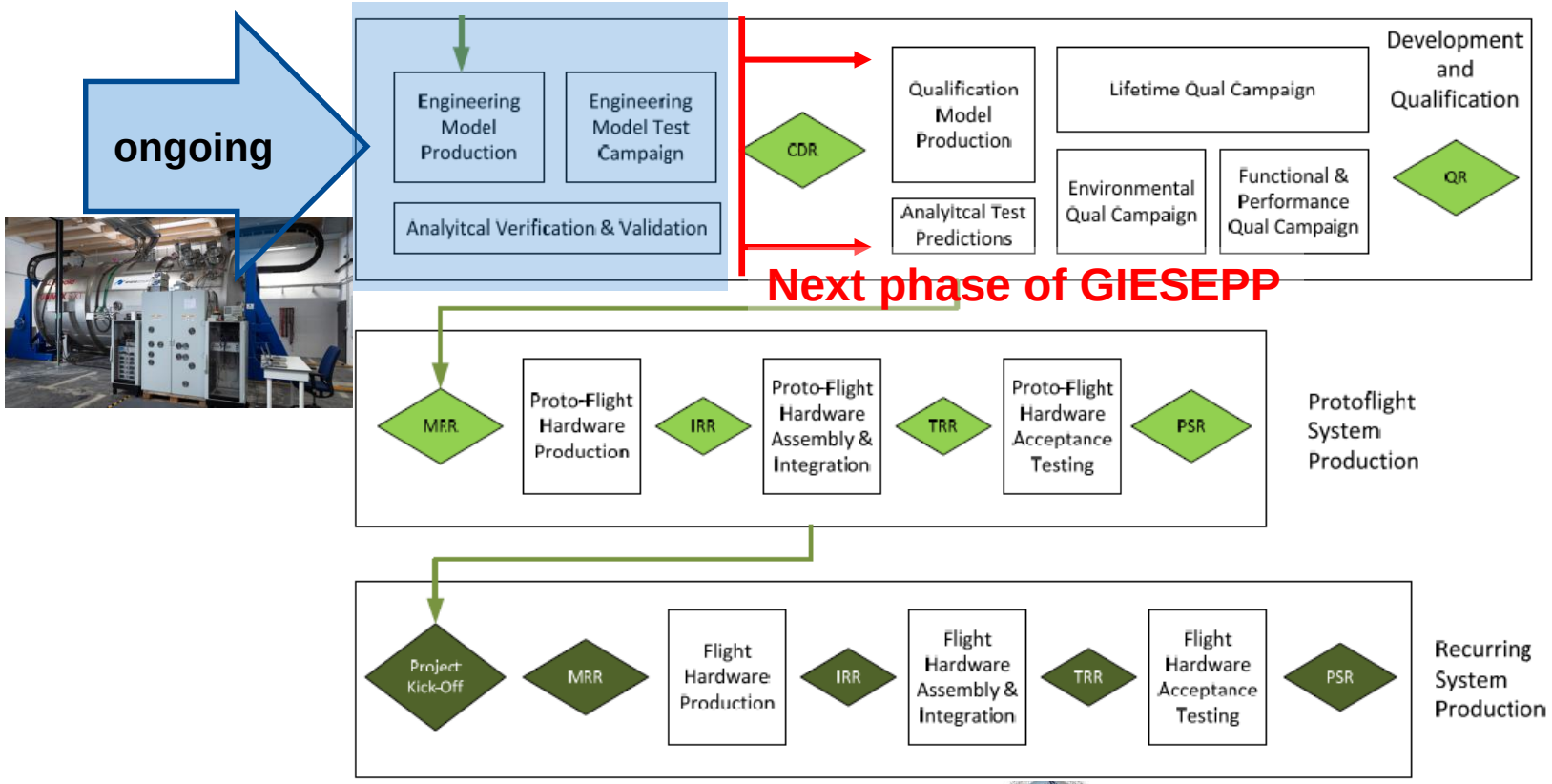
GIESEPP - ACTIVITIES AND SCHEDULE – NEXT PHASE (3/3)



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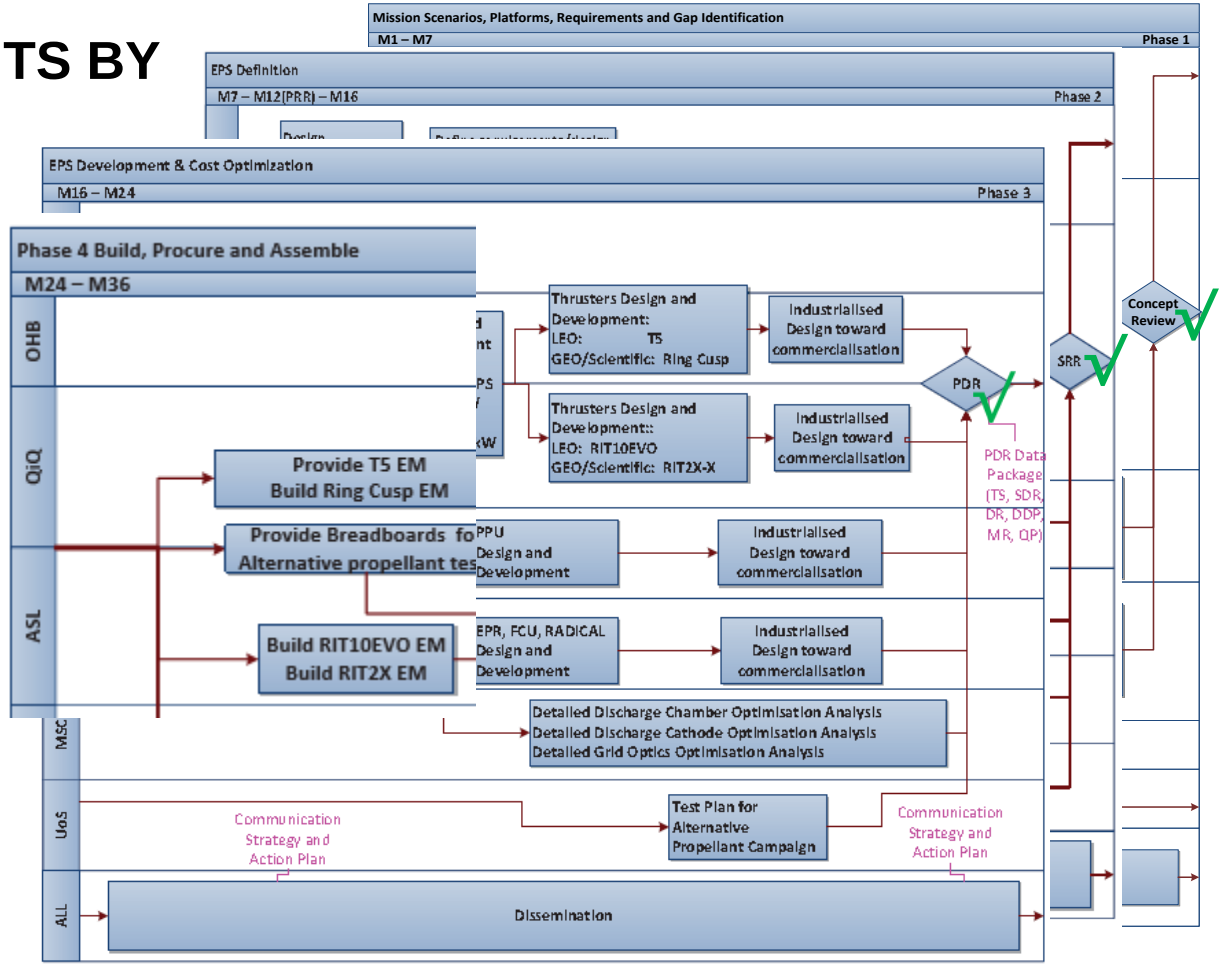
GIESEPP - ACHIEVEMENTS BY TODAY

- ✓ ***Phase 1 done***: Concept review successful
- ✓ ***Phase 2 done*** : SRR successful
- ✓ ***Phase 3 done:*** PDRs successful
- ✓ ***Phase 4 started***
- ✓ ***Consolidated requirements*** on all levels
- ✓ ***Market Survey*** and reflection on requirements
- ✓ Consolidation on ***modularity***
- ✓ ***Trade-offs*** finalized
- ✓ Enhanced discharge chamber and ion optics ***modelling***
- ✓ ***Alternative propellants*** assessment and pre-selection
- ✓ ***Industrialization*** activities ongoing
- ✓ ***TCO*** investigations
- ✓ ***Test Specimen*** MAIT started



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05
MARKET ASSESSMENT

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GIESEPP – MARKET SURVEY RESULTS

- ✓ During summer/fall 2018
- ✓ 40+ stakeholders in space propulsion (institutions, integrators, operators)

	LEO				GEO		
	Range	**GIESEPP**	**Comment**		**Range**	**GIESEPP**	**Comment**
Lifetime [a]	3 – 10	***10***	Potential trade-off wrt costs		10 – 20	***16,2***	To be reviewed for further ext.
EPS Power [W]	200 – 2000	***200-700***	Further extension considered		OR: 3000 – 21000 SK: 2000 – 4000	***OR: 11000*** ***SK: 3000***	With 2 EPS
Total Impulse [MNs]	0,2 – 2	***1,0***	See lifetime		OR: 3 – 10 SK: 1 – 8	***OR: 7,2*** ***SK: 4,2***	
Thrust [mN]	15 – 50	***22,5***	Potential extension with pwr		OR: 150 -300 SK: 25 – 200	***OR: 228*** ***SK: 124***	Up to 249 in high thrust
ISP [s]	2000-5000	***3000***			OR: 2000 – 4000 SK: 2000 – 5000	***OR: 2500*** ***SK: 3500***	

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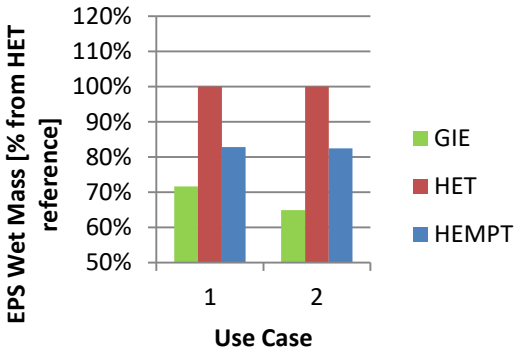
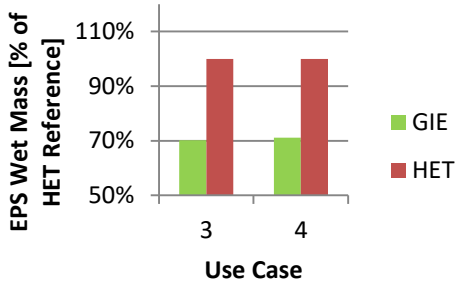
GIESEPP – TCO ASSESSMENT (1)

- ***See IEPC-2019-A883 More Added Value?***
- ***Extend*** the pure engineering-centric view
- Consider ***full S/C life*** cycle
- ***Link*** one end of „the chain“ (operators) with the other end (EPS suppliers)
- Establish a fundamental ***comparison*** in EPS
- Initially ***4 use cases***:
  - ✓ Heavy GEO
  - ✓ Small GEO
  - ✓ LEO constellation, small sat
  - ✓ LEO constellation, medium sat

EPS Wet Mass

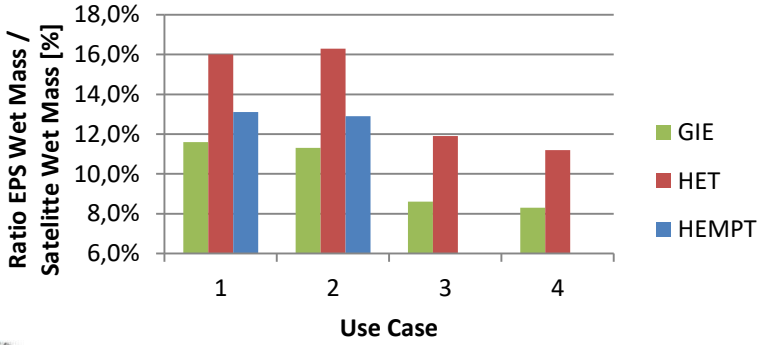
- For GEO reduced down to 65%
- For LEO reduced down to 70%





EPS Wet Mass / Satellite Wet Mass

- For GEO reduced down to 11.6%
- For LEO reduced down to 8.3%



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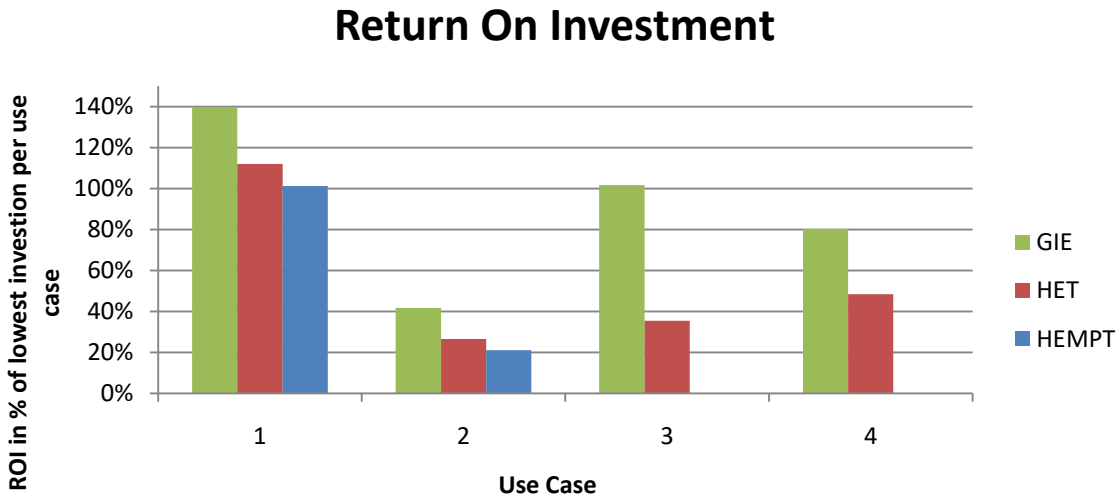
GIESEPP – TCO ASSESSMENT (2)

Return On Investment



- Maximum life extension on GEO ➔ ROI Δ up to (39%) 100%
- Maximum launch mass on LEO ➔ ROI Δ up to 127% (36%)

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