

RFC: Space Debris – Waste or Value?

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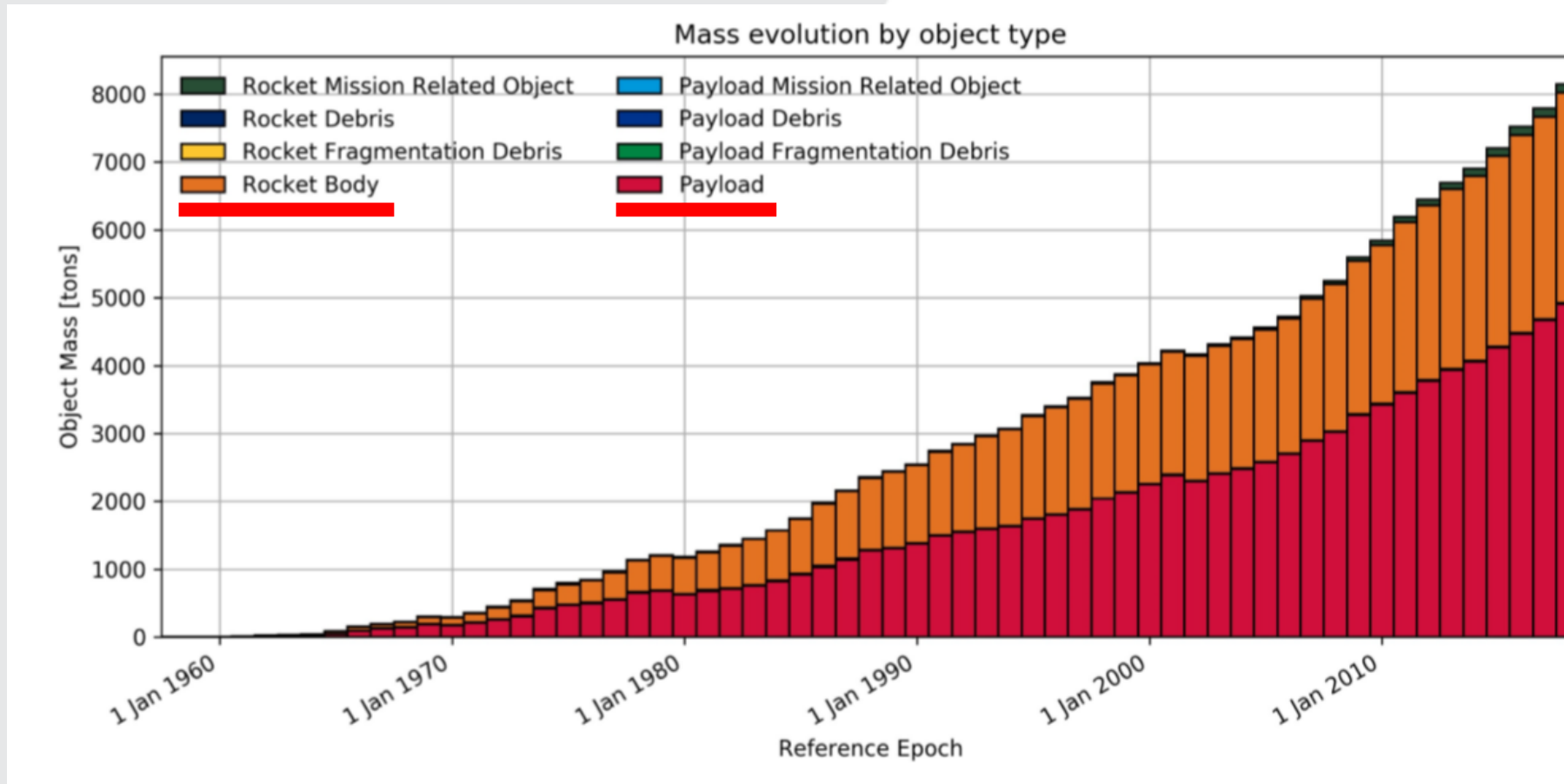
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Wertstoff aus dem All

What does it cost to launch 8,000 tons into space?



- ~ 800 Ariane launches needed
- ~ 80 billion Euro launch costs
- 8,000 tons in space = 80 billion Euro

What are 8,000 tons of space debris made of?

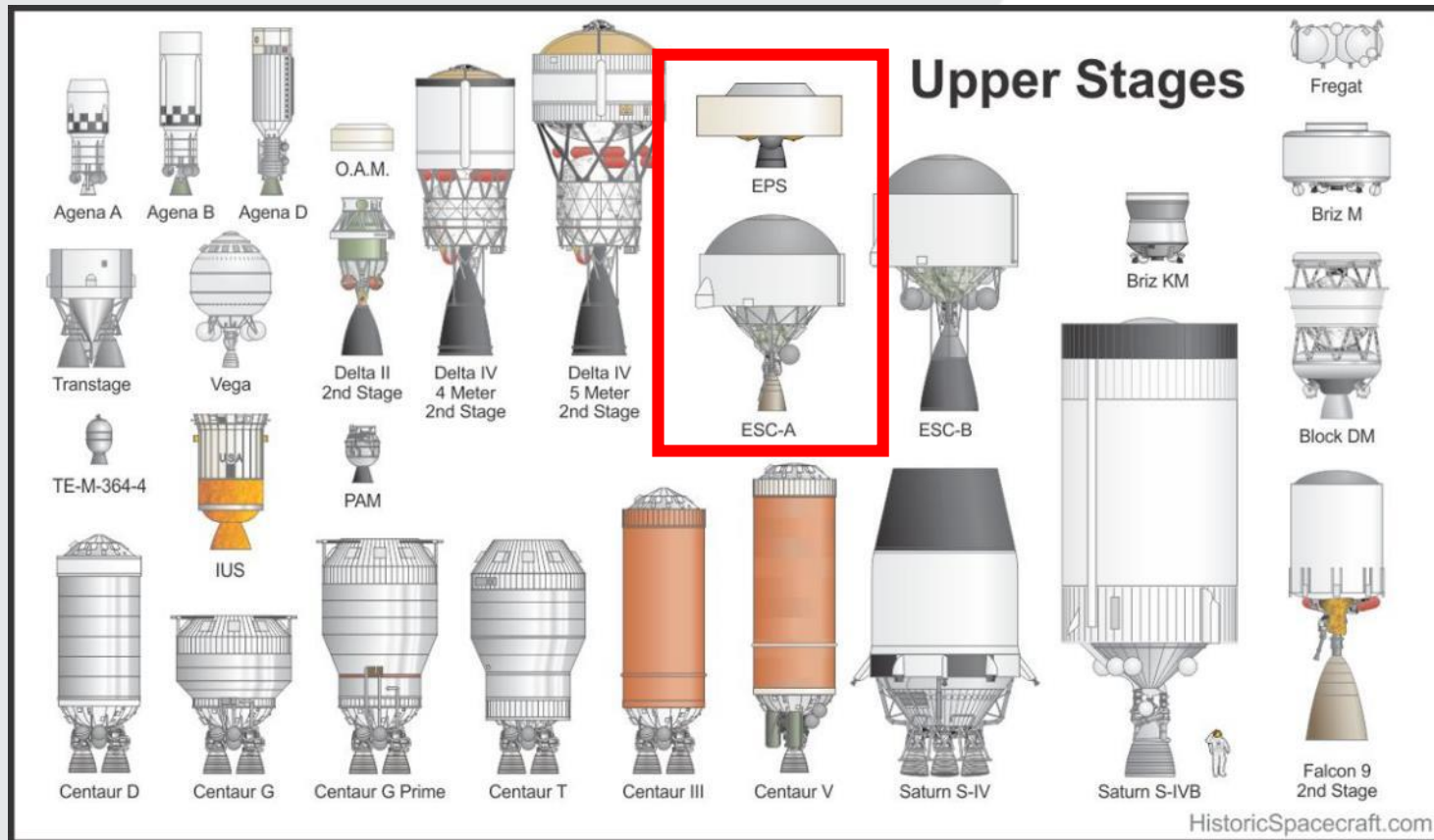


ESA Space Debris Study: mass by object type

Meaningful “hand-made” payloads...



...and valuable “mass-produced” rocket bodies



Upper stage value 1: many massive structures



Ariane
ESC-A upper stage

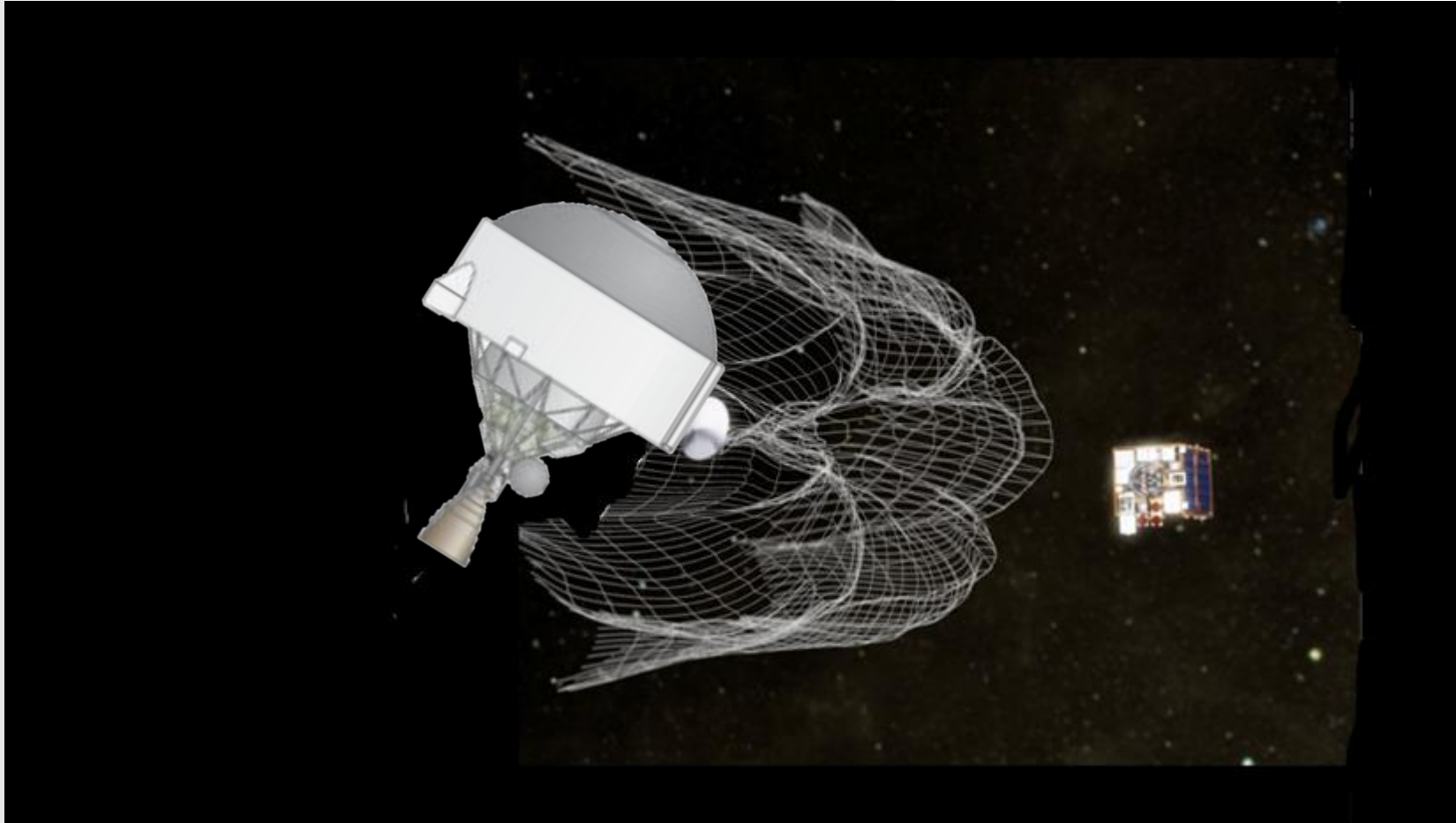
4 tons Aluminium
64 of them in GTO or higher



Aluminium used as
foil, structure, foam, powder



Upper stage value 2: simple shapes & connectors

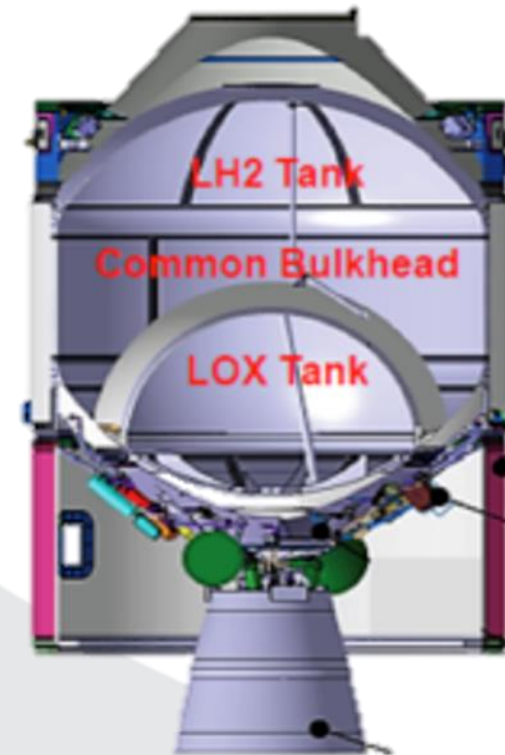
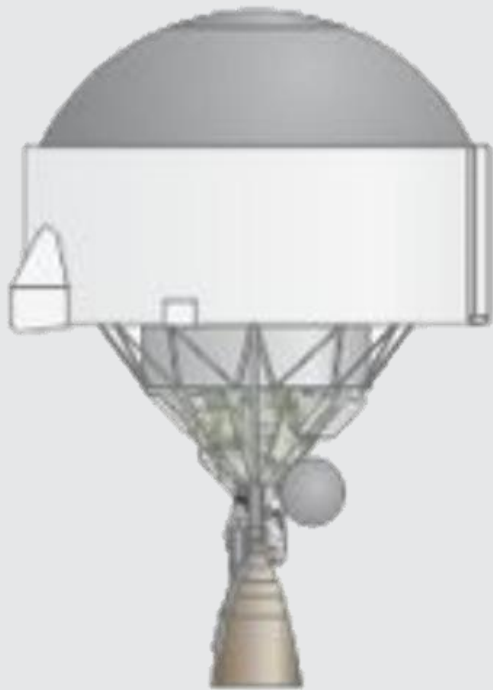


Upper stage value 3: useful storage capacity(?)

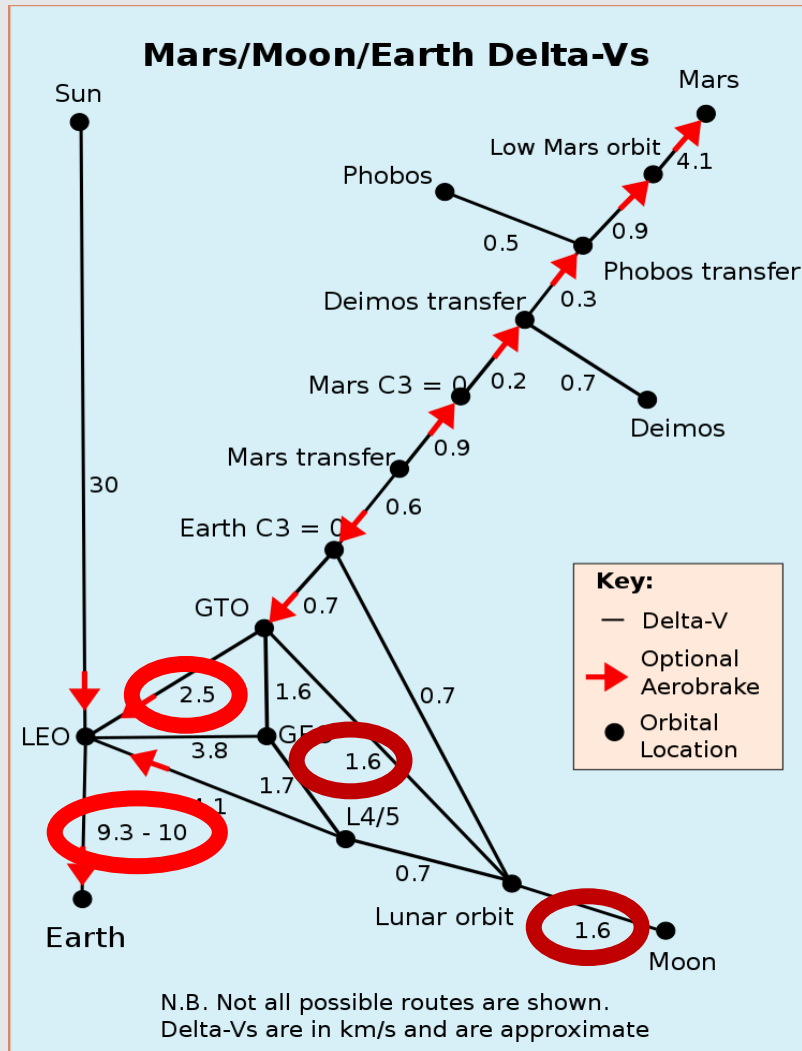
Storage Capacity

2,6t LH2

12t LO2

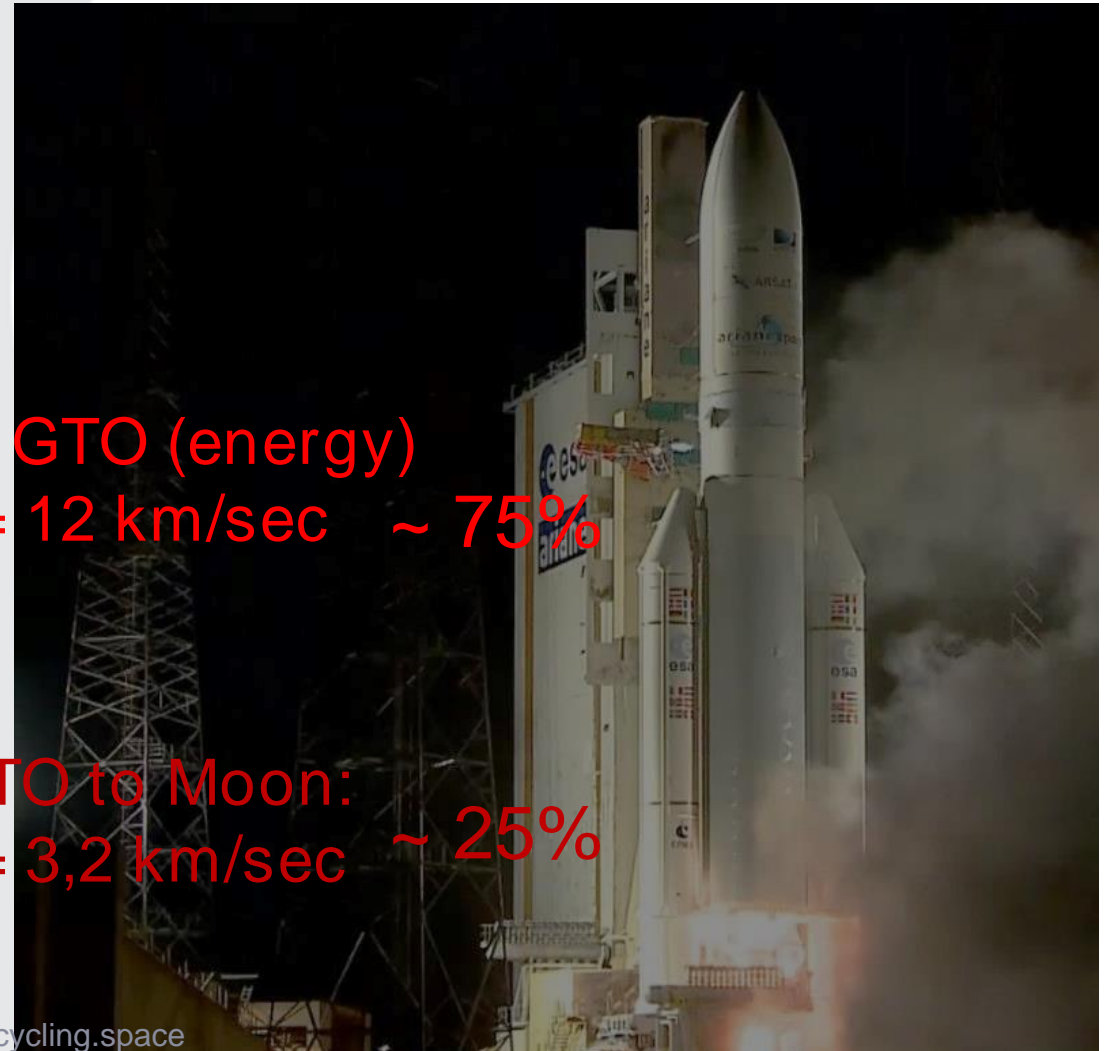


Upper stage value 4: their “paid” location in space



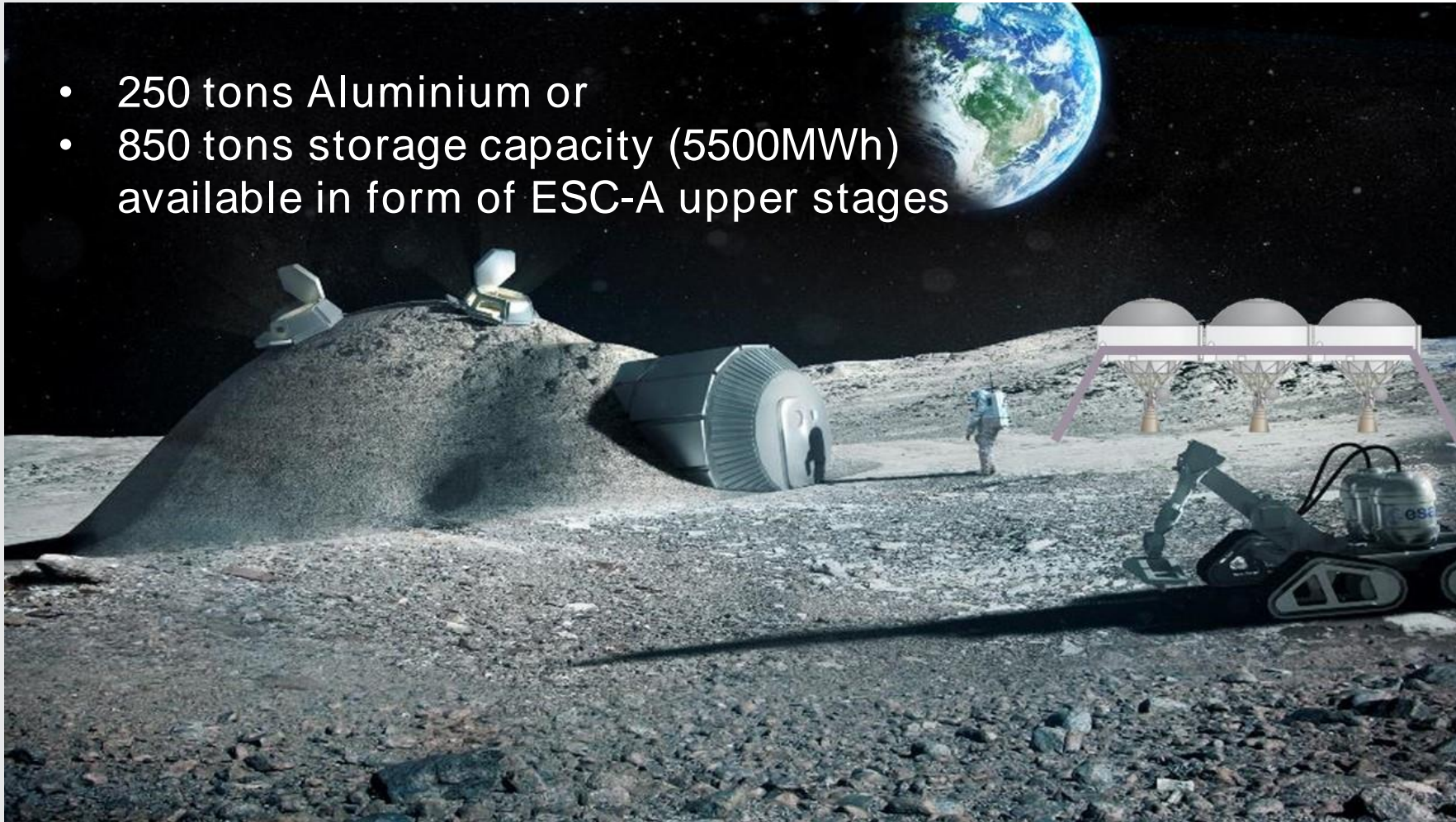
Delta-v to GTO (energy)
 $9,5 + 2,5 = 12 \text{ km/sec} \sim 75\%$

Delta-v GTO to Moon:
 $1,6 + 1,6 = 3,2 \text{ km/sec} \sim 25\%$



The Moon station would benefit from these values

- 250 tons Aluminium or
- 850 tons storage capacity (5500MWh) available in form of ESC-A upper stages



Savings of >6,000 Mio Euro



- 1 Launch into GTO (>10 tons payload):
 - Up to 4 SSV (2t each)
 - Each SSV might move 1-2 upper stages
- 16 - 32 tons to the Moon

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- 8 Launches into lunar transfer (<7 tons):
 - Spaceship with propulsion and net payload < 4 tons
- 16 - 32 tons on the moon

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A Gedankenexperiment: re-using rockets, but differently? (Is there only the SpaceX way to re-use rockets?)

- If max. payload weight is not used, could upper stages de-orbit themselves in direction Moon instead of Earth?
 - Additional propulsion, restartable engines,...
 - Could a small SSV (e-propulsion?) added as an additional payload?
 - Time for moon trajectory not important
- Could re-using upper stages be a “paid” offering?
 - Could material or tank value re-finance Ariane launches making them more competitive?
 - Could satellites be designed for their missions AND for their second life to refinance their mission costs partly?

Summary

- There are 8,000+ tons of space debris in orbit
 - Just waste? Or partly valuable?
 - E.g. 60+ Ariane upper stages (250 tons Aluminium / 850 tons storage capacity)
- SSVs: just for de-orbiting / servicing satellites?
 - Roughly same weight of upper stages in orbit
 - Additional companion research to ESA e.Deorbit / RemoveDebris needed
- The saving opportunity is ~ several billion Euros
 - Economic savings + reduced environmental pollution (launches)
 - ESA could leapfrog all space agencies & help the EU to reach climate goals

Thank You!

Please share your thoughts & comments

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