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A market analysis for commercial ISRU production

Market Analysis

- What is the product?
- Where is it needed?
- Who is the customer?
- What is the value of the product where the customer needs it?

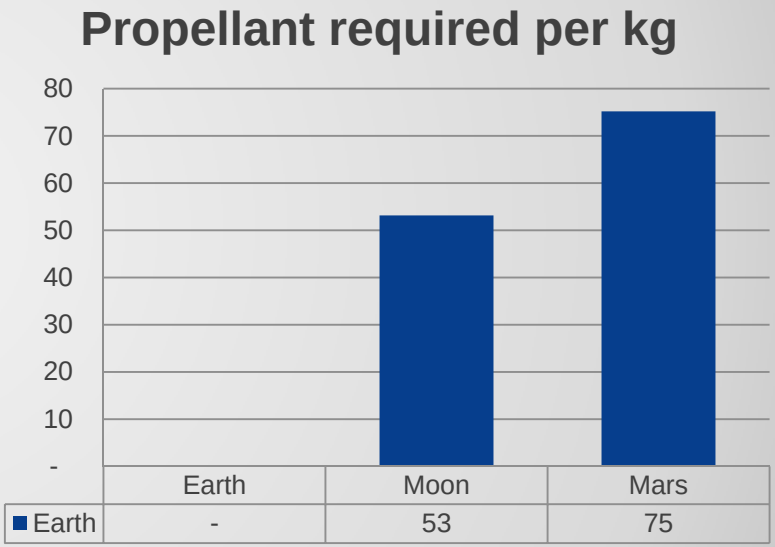
Why choose propellant for ISRU?

Largest Proportion of launch payload from Earth >90%

- For every kg delivered
  - to the moon, need 53 kg fuel..
    - or a total of 424kg fuel for every 1kg returned to LEO
  - To Mars, need 75 kg fuel
    - Or a total of 675kg for every 1kg returned to LEO.

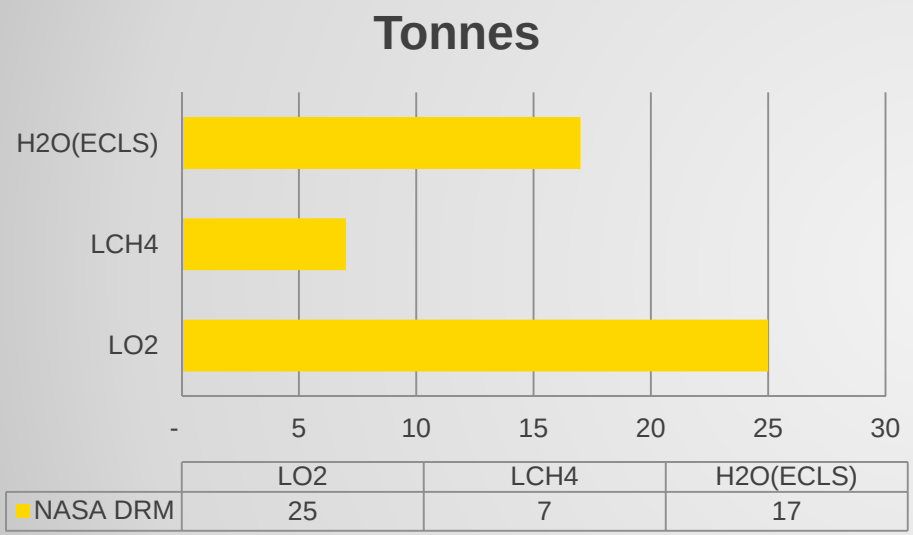
Relatively Simple, Easy to Automate, Generation Processes

- Electrolysis ,Sabatier, Reverse Water Gas Shift
- For every kg of total ISRU system mass delivered to Mars*
  - A Lox/LCH4 ISRU system can produce **20** kg of propellant
  - A Lox-only ISRU system can produce **3** kg of propellant

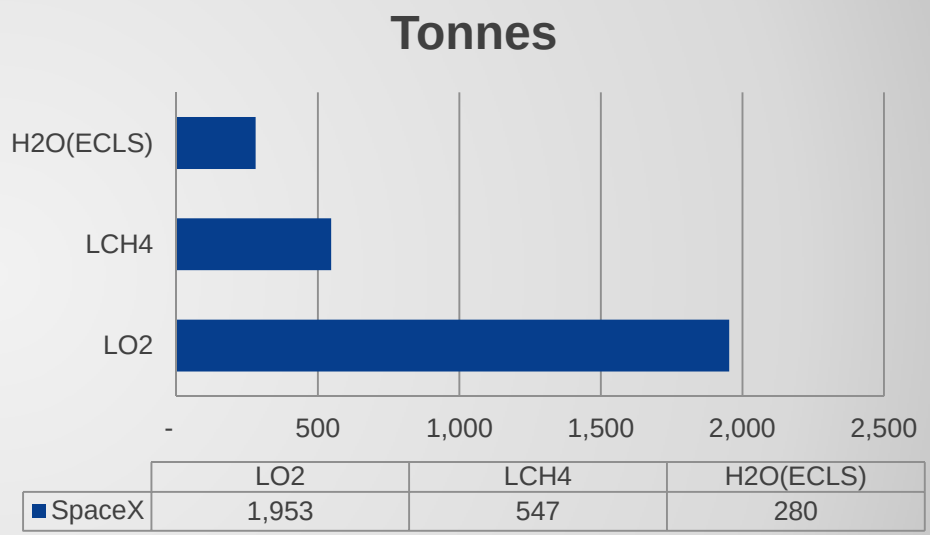


* Abbud-Madrid et al, 2016, Report of the Mars Water In-Situ Resource Utilization (ISRU) Planning (M-WIP) Study; 90 p, posted April, 2016 at http://mepag.nasa.gov/reports/Mars_Water_ISRU_Study.pptx

Potential Demand(Mars)

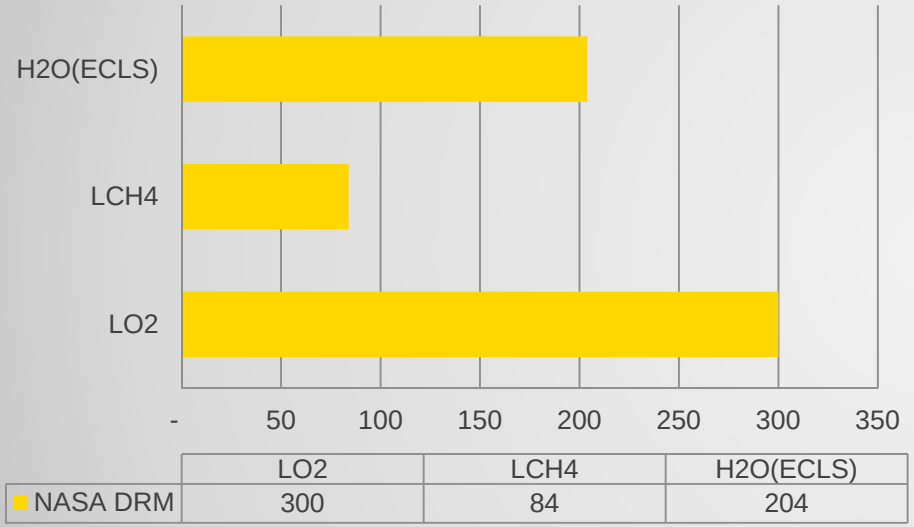


	LO2	LCH4	H2O(ECLS)
NASA DRM	25	7	17

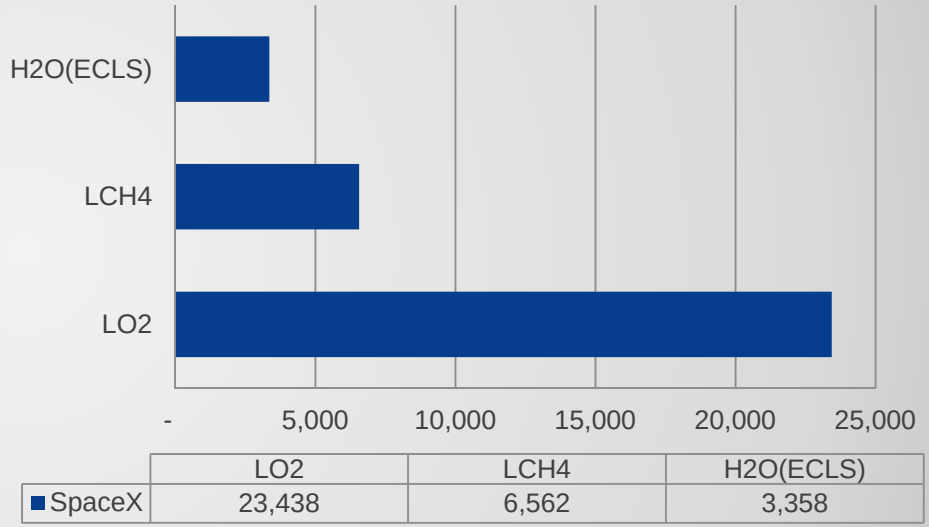


	LO2	LCH4	H2O(ECLS)
SpaceX	1,953	547	280

Potential Revenue , k$



	LO2	LCH4	H2O(ECLS)
NASA DRM	300	84	204



	LO2	LCH4	H2O(ECLS)
SpaceX	23,438	6,562	3,358

- Based on US$160/kg O2 cost
- Does not include cost of saved launches.

Next Steps for Commercial Development

- Identify and Prove Resources
- Identify, Develop and Prove ISRU Technologies
- Evaluate Ideal Storage Locations
- Establish Funding

Other Commercial ISRU Potential

- Other Resources
  - Moon
  - Asteroids
  - Earth LEO
- Other Products
  - Solar Panels
  - 3D Printing feedstock
  - Batteries
- Other Locations
  - Arctic and Antarctic Science Stations
  - Remote Mine Sites
  - Remote Communities

Conclusion

- There is potentially significant market for ISRU consumables
- Resource Exploration and Technology needs to invested in.