GPoD Power Analysis and other projects.

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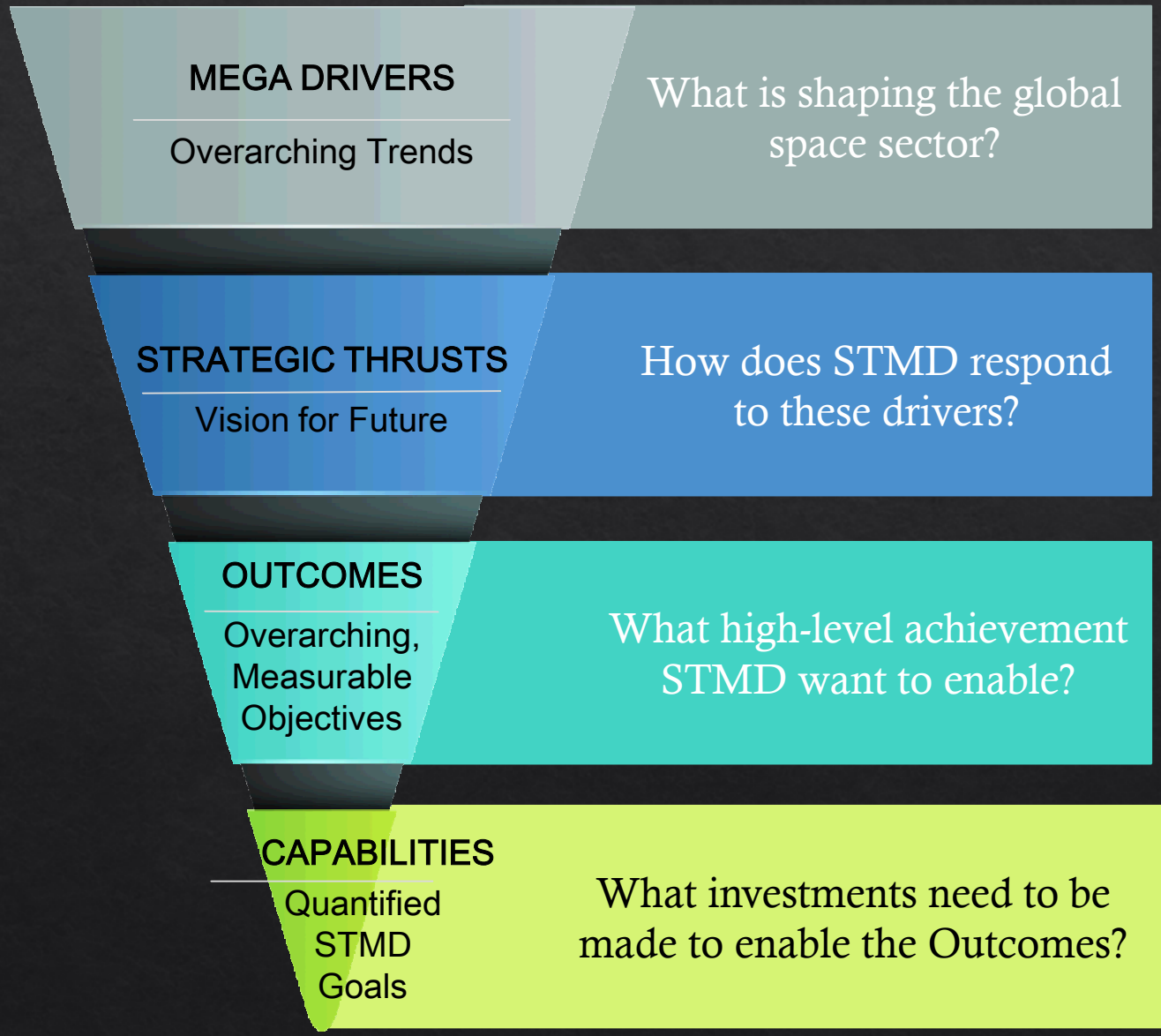
Background

- University of Pittsburgh 2008-2013
  - B.A. European History focused on medieval law and politics
- United States Marine Corps 2014-2018
  - Fire Direction Controlman 11th Marines
- New Mexico State University (NMSU) 2018-Present
  - Major: Mechanical Engineering
  - Minor: Material Sciences

Technology Development Framework

- STMD has developed a strategic technology development framework in order to better maximize the impact of their investments. This framework is broken down into four sections.
  - Mega Drivers
  - Strategic Thrusts
  - Outcomes
  - Capabilities

STMD Technology Development Framework



Capabilities:

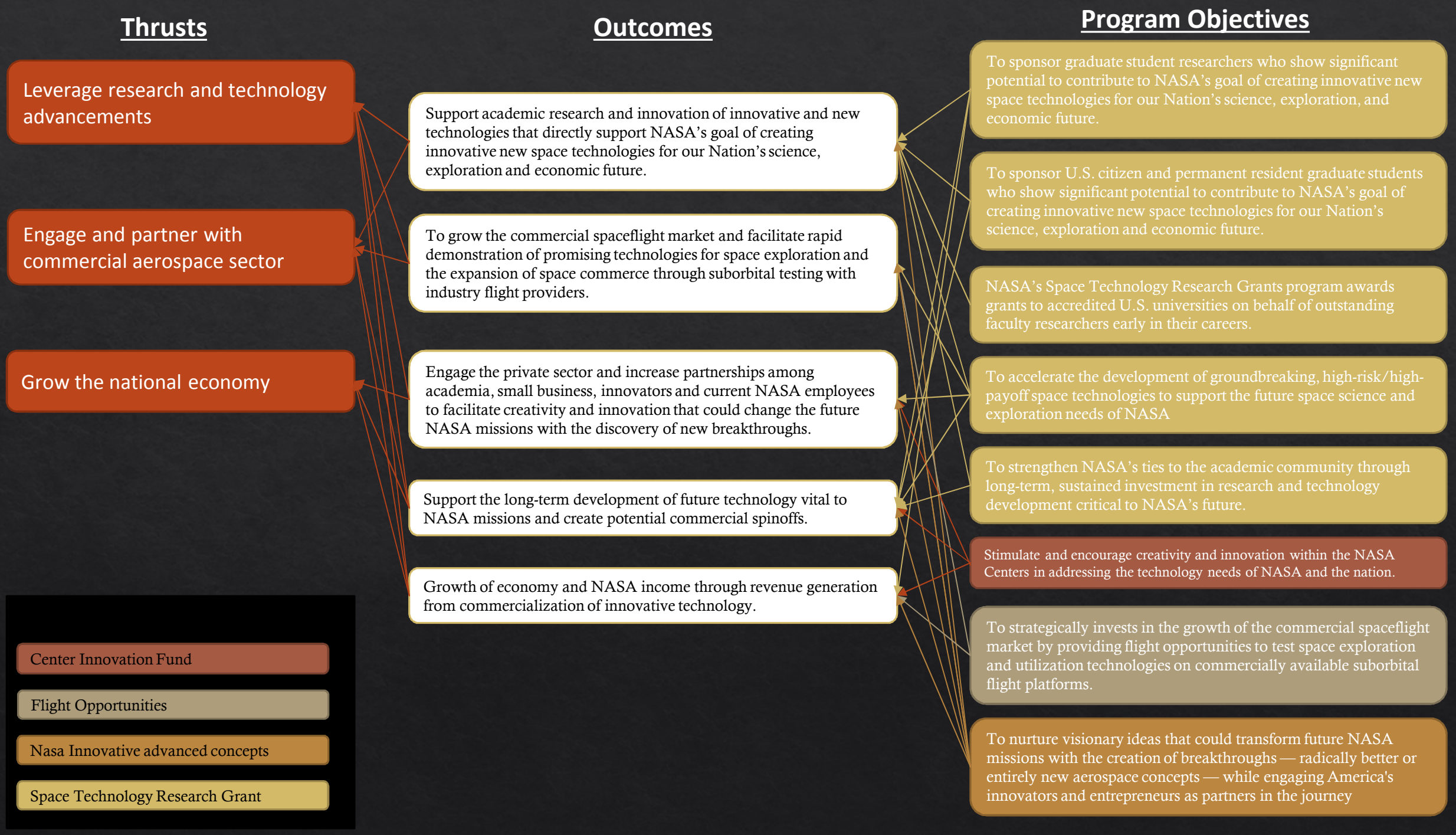
- *Focus investments* STMD investments
- *Address needs* through Outcomes
- *Communicate the value* STMD provides to customers
- *Develop technical challenges* for STMD projects

Technology Development Framework

- Over the course of the past year STMD has been decomposing their old set of outcomes into a more refined direct set.
- The goal was to map old outcome decompositions to the newly established outcomes making sure each new outcome fully encompassed the direction set out by the old set.
- Once the outcomes were mapped, we re-worked the thrust papers, which were papers that laid out the direction of how the capabilities and outcomes mapped into each of the four thrusts of Go, Land, Live, Explore.

Commerce Framework

- STMD does more then just technology research, they have begun to develop a Commerce Framework. Similar to the technology development framework, the commerce frameworks goal is to help frame technology transfer and maximize space technology commercialization and generate economic and quality of life benefits for the Nation.
- Conducted research into the objectives of
  - Center Innovation Fund
  - Flight Opportunities Program
  - Nasa Innovative advanced concepts program
  - Space Technology Research Grant
- The goal of the research was to formulate a set of desired outcomes for the newly created Commerce Framework in support of STMD


Thrusts
Leverage research and technology advancements
Engage and partner with commercial aerospace sector
Grow the national economy
Outcomes
Support academic research and innovation of innovative and new technologies that directly support NASA's goal of creating innovative new space technologies for our Nation's science, exploration and economic future.
To grow the commercial spaceflight market and facilitate rapid demonstration of promising technologies for space exploration and the expansion of space commerce through suborbital testing with industry flight providers.
Engage the private sector and increase partnerships among academia, small business, innovators and current NASA employees to facilitate creativity and innovation that could change the future NASA missions with the discovery of new breakthroughs.
Support the long-term development of future technology vital to NASA missions and create potential commercial spinoffs.
Growth of economy and NASA income through revenue generation from commercialization of innovative technology.
Program Objectives
To sponsor graduate student researchers who show significant potential to contribute to NASA's goal of creating innovative new space technologies for our Nation's science, exploration, and economic future.
To sponsor U.S. citizen and permanent resident graduate students who show significant potential to contribute to NASA's goal of creating innovative new space technologies for our Nation's science, exploration and economic future.
NASA's Space Technology Research Grants program awards grants to accredited U.S. universities on behalf of outstanding faculty researchers early in their careers.
To accelerate the development of groundbreaking, high-risk/high-payoff space technologies to support the future space science and exploration needs of NASA
To strengthen NASA's ties to the academic community through long-term, sustained investment in research and technology development critical to NASA's future.
Stimulate and encourage creativity and innovation within the NASA Centers in addressing the technology needs of NASA and the nation.
To strategically invests in the growth of the commercial spaceflight market by providing flight opportunities to test space exploration and utilization technologies on commercially available suborbital flight platforms.
To nurture visionary ideas that could transform future NASA missions with the creation of breakthroughs — radically better or entirely new aerospace concepts — while engaging America's innovators and entrepreneurs as partners in the journey
Center Innovation Fund
Flight Opportunities
Nasa Innovative advanced concepts
Space Technology Research Grant

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Potential Outcomes for STMD's Commerce Framework

THRUSTS	OUTCOMES

STMD makes investments in order to foster growth in:

Academia

Engage and foster academic aerospace research, development, and partnerships

- U.S. is #1 in the world in number of STEM graduates per capita
- Number of universities engaged in aerospace research or partnerships exceed [TBD]

Commercial Space

Engage and foster the commercial space sector

- Private investment in the space sector exceeds $5B annually
- Number new commercial space companies exceeds [TBD] annually
- Number of employees in the U.S. space sector exceeds [TBD]
- [TBD%] of STMD projects have commercial/private collaboration

National Economy

Contribute to the growth of the national economy beyond the space sector

- Increase national return on investment for the NASA budget to 10:1
- 90% [TBD]) of NASA's technologies are used for commercial purposes
- Number of companies with NASA partnerships exceeds [TBD]
- Number of new companies enabled by NASA investment exceeds [TBD]

Slide 8

EB(SRA1 THis has gone up to STMD senior leadership, and is still being discussed and worked on today and will continue to be worked on in the future.
Eichmiller, Barry (LARC-E402)[UNIVERSITIES SPACE RESEARCH ASSOCIATION], 8/7/2019

Historical Database

- The SMAB is trying to build a database of all historical information concerning space flight. From historical launch systems, launches, and manned missions.
- The goal is to support systems analysis and create an easily searchable historical knowledgebase.
- Updated a document with all historic and current launch's from all space agencies.
- Broke the document down into parsed sections to be uploaded to the NASA historical database.

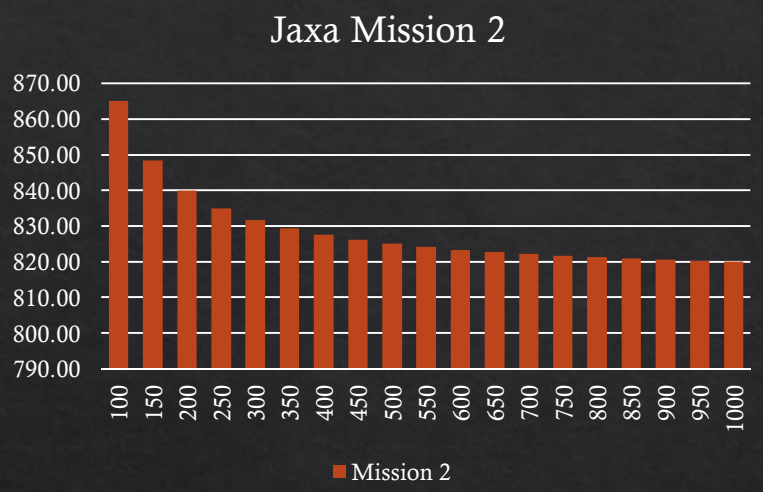
GPoD Power Analysis

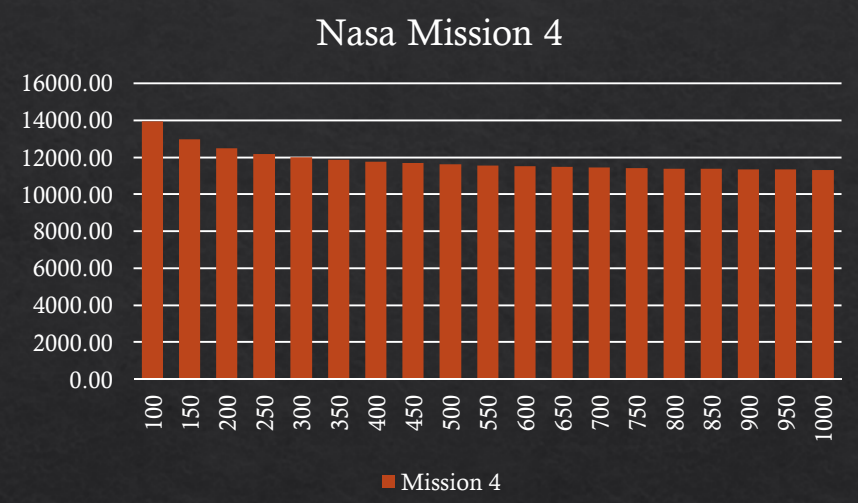
- GPoD (Global Point of Departure) is a multi agency lunar mission between NASA, JAXA, ESA
- The goal was to find the relationship of battery specific energy (W-hr/kg) to surface architecture mass for both battery and fuel cell architectures and then decide what realistic specific energy should we target moving forward in tech development and investment.
- To do this I broke down the first set of missions into its separate elements. I then recalculated the mass of any elements that had a battery specific energy using a range of 100 W-hr/kg to 1000W-hr/kg for batteries and 500 W-hr/kg to 1500 W-hr/kg for fuel cells.
- After finding the new masses I then re-calculated the total mission weight with the changed mass for only batteries assuming fuel cell elements remained the same, and then a second set with the reverse assumptions made.

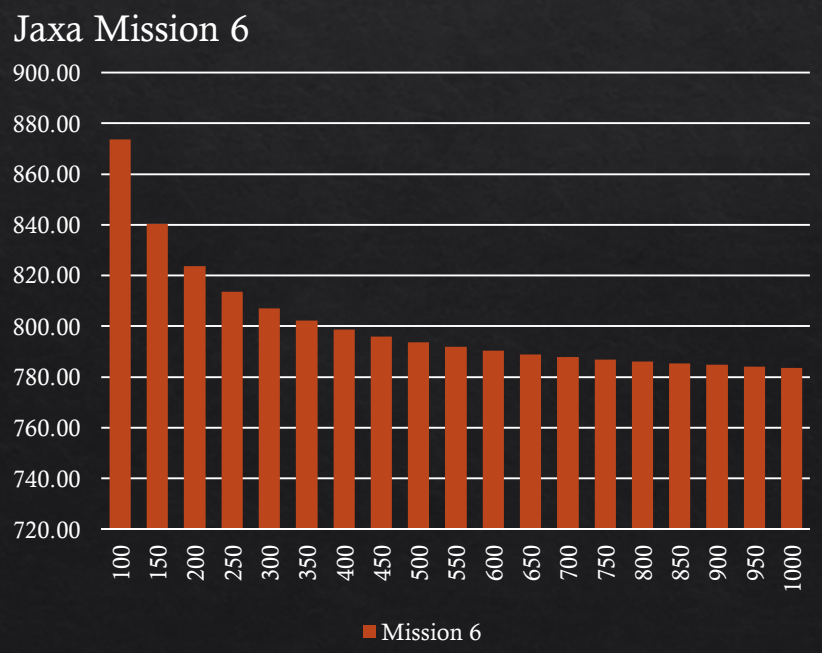
GPoD Power Analysis

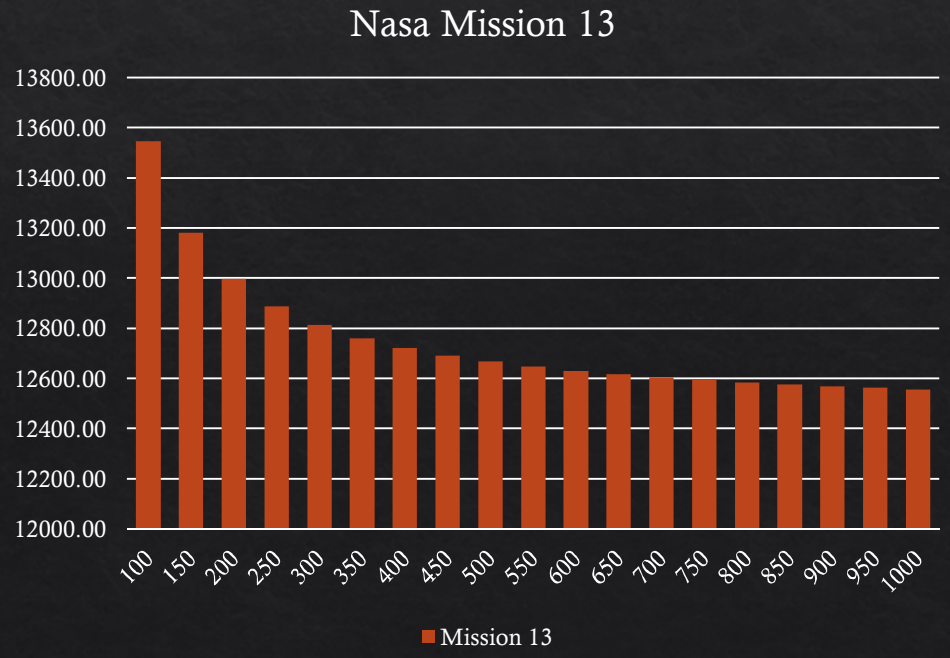
- GPoD Assumptions
  - Nasa Lander Capabilities 14.5t
  - ESA Lander Capabilities 1.5t
  - JAXA Lander Capabilities < 1t
  - Battery Technology 150 W-hr/kg
  - NASA Fuel Cell Technology 700 W-hr/kg average
  - ESA Fuel Cell Technology 365 W-hr/kg
  - JAXA Fuel Cell Technology 465 W-hr/kg

Battery Missions





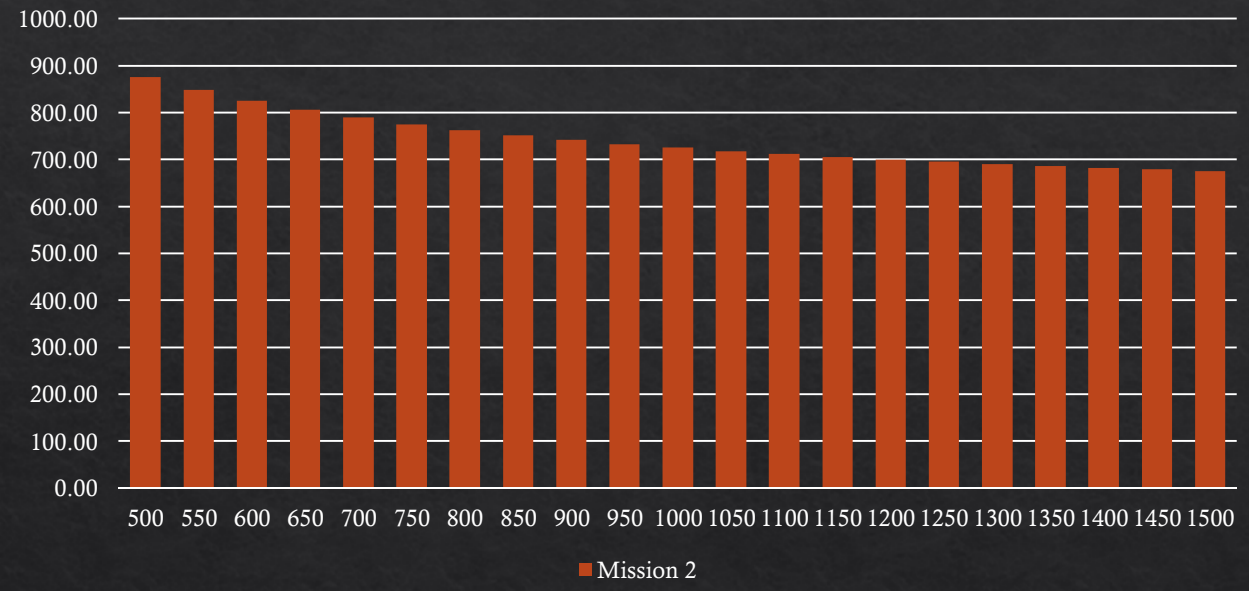




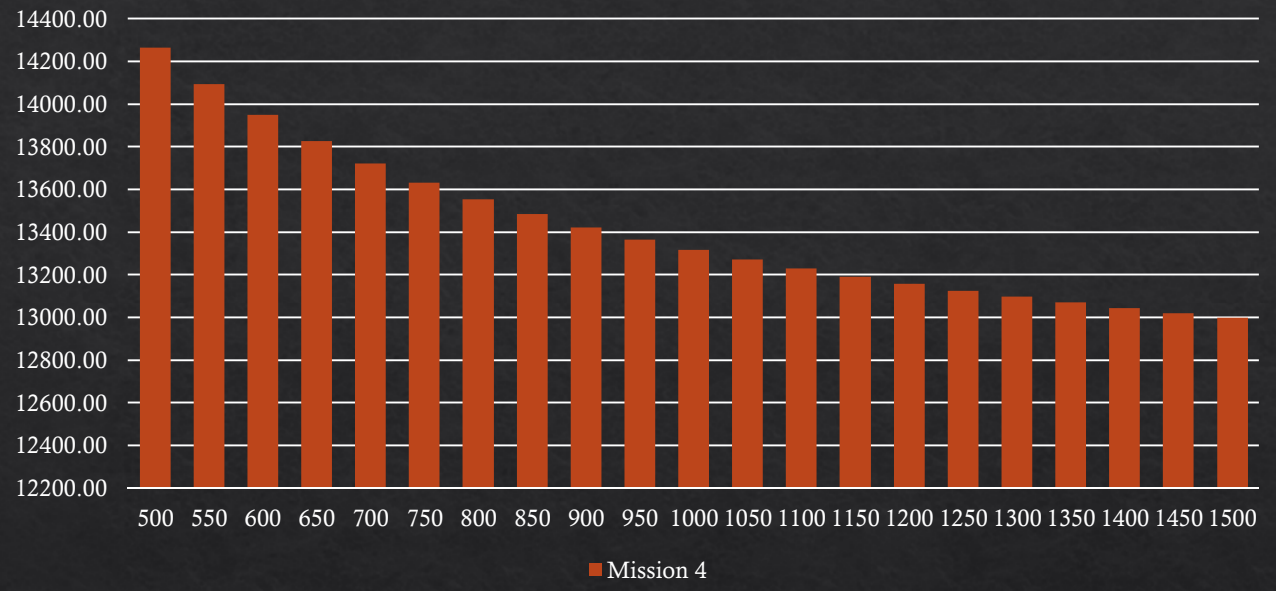
After running the analysis we can see that beyond 450-500 W-hr/kg the weight change is nominal

Fuel Cell Missions

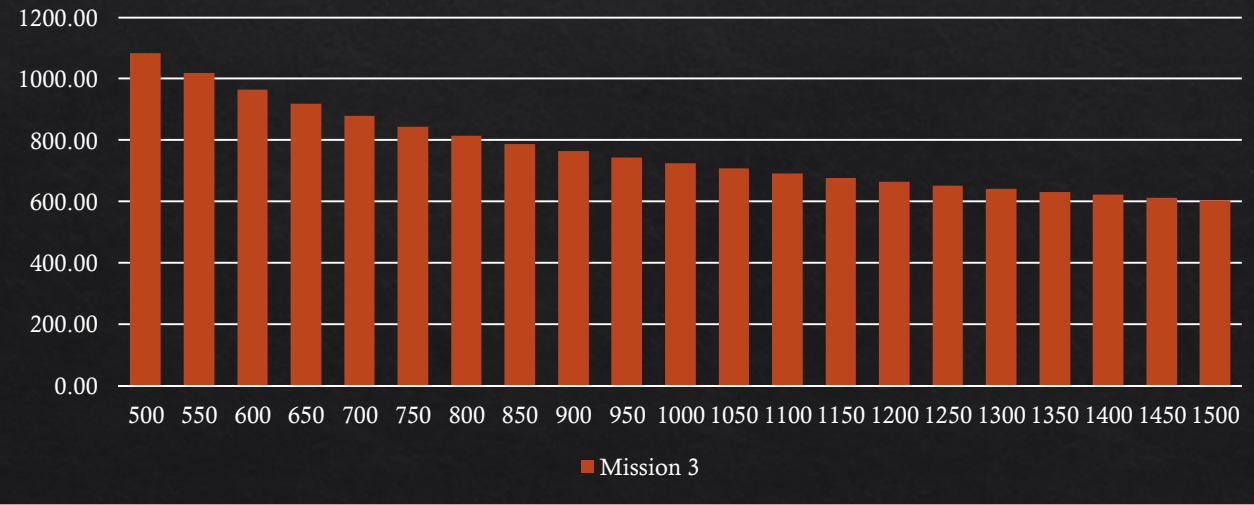
JAXA Mission 2



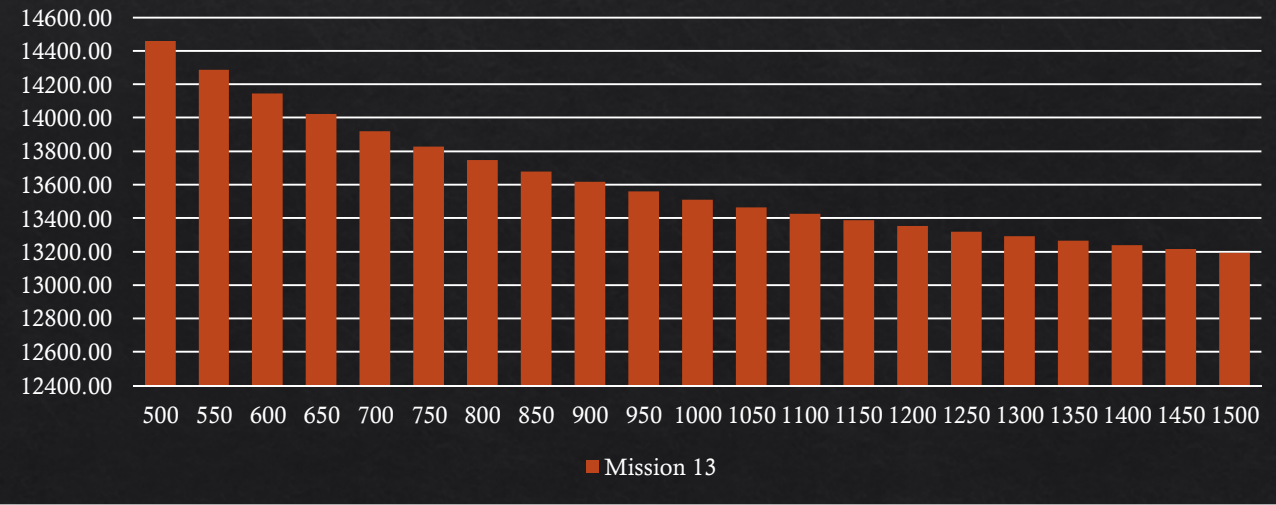
NASA Mission 4



ESA Mission 3



NASA Mission 13



Results

- Fuel cells begin to have a similar leveling off at the 1500 W-hr/kg.
- From this my recommendation would be to invest in battery technology to get us to the 500 W-hr/kg and to continue exploring the idea of advanced fuel cell and regenerative fuel cell designs/

What Is Next

- Systems analysis and big picture
- Vacation to Mexico on Sunday
- Return to NMSU for Fall of 2019
- On track to graduate Spring of 2021

Questions?