A Lunar Volatiles Miner

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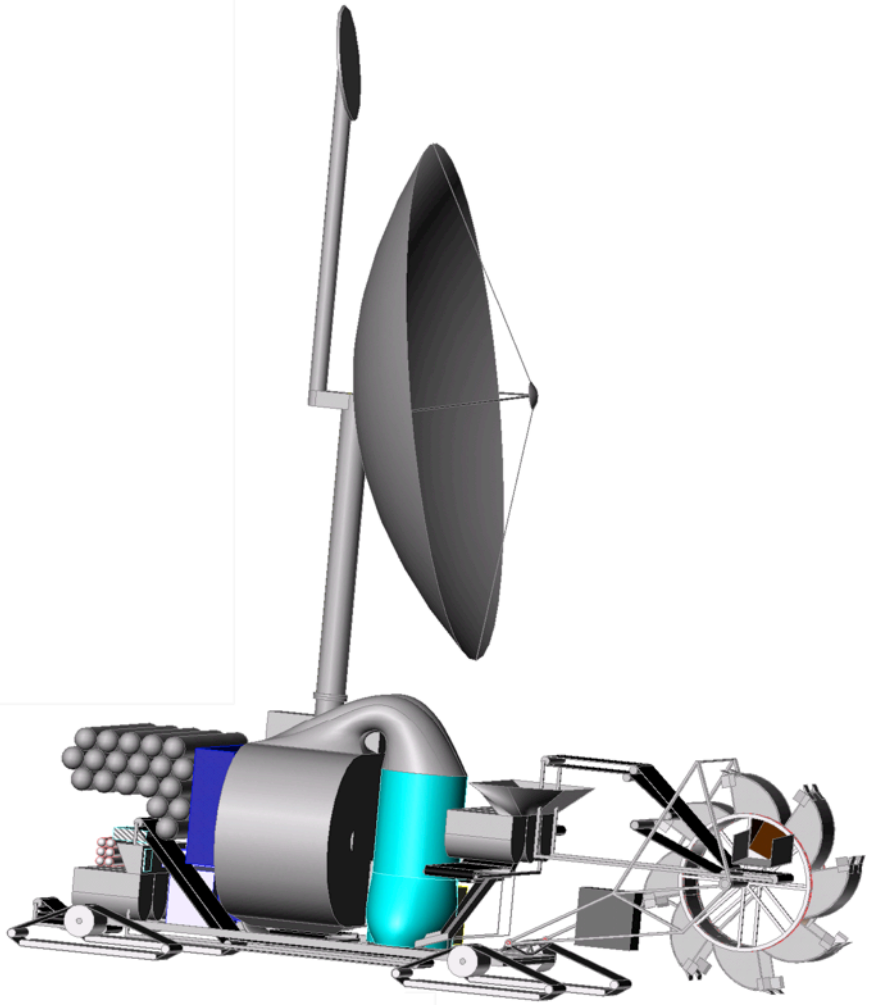
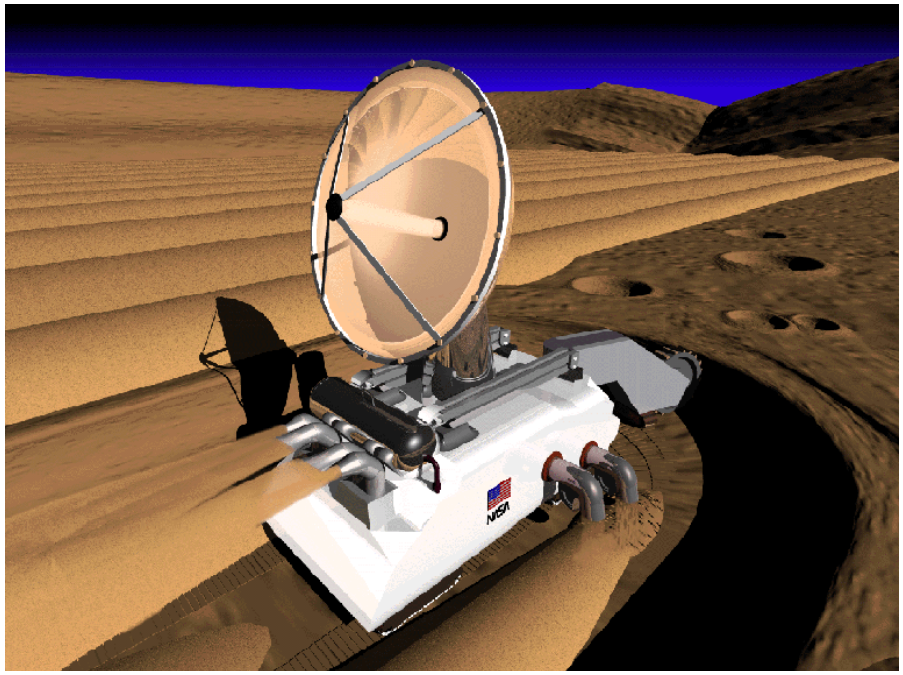


Introduction

- Excavate lunar regolith
- Sort regolith and process small fines (< 100 μm)
- Heat small fines to 700 ºC
  - Solar wind volatiles extracted: H_2, ^4He, ^3He, CO_2, CO, CH_4, N_2, H_2O
- Store volatiles

Background*

- Mark II designed in early 1990's
  - Empty Mass: 18 tonnes
  - Power usage: 200 kW_e
- Mine 1 km^2, 3 m deep, per year
- Extract 1650 kg of volatiles every Earth day



*Sviatoslavsky, I. N. (1993 February). *The Challenge of Mining He-3 on the Lunar Surface: How All the Parts Fit Together.* Proceedings of Space 94, The 4th International Conference and Exposition of Engineering, Construction and Operations in Space, Albuquerque, NM

Volatiles Extracted

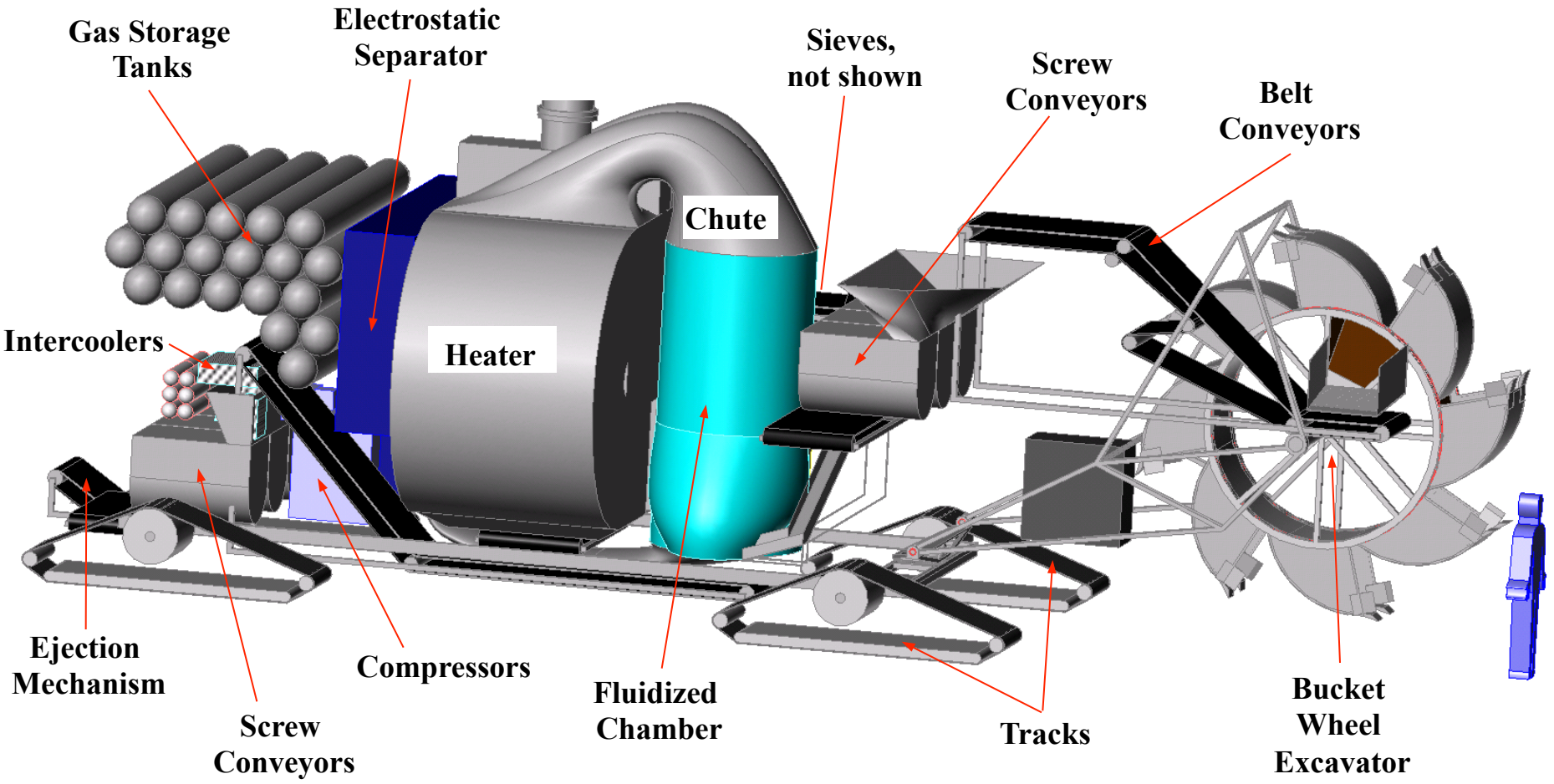
- Life support
  - Atmosphere
  - Water
  - Food
- Water support for over 750 inhabitants per miner

Mass of Volatiles Extracted (tonnes/yr)	
H_2O	108.9
N_2	16.5
CO_2	56.1
H_2	201.3
^4He	102.3
CH_4	52.8
CO	62.7
^3He	0.033

Mark III Design Goals

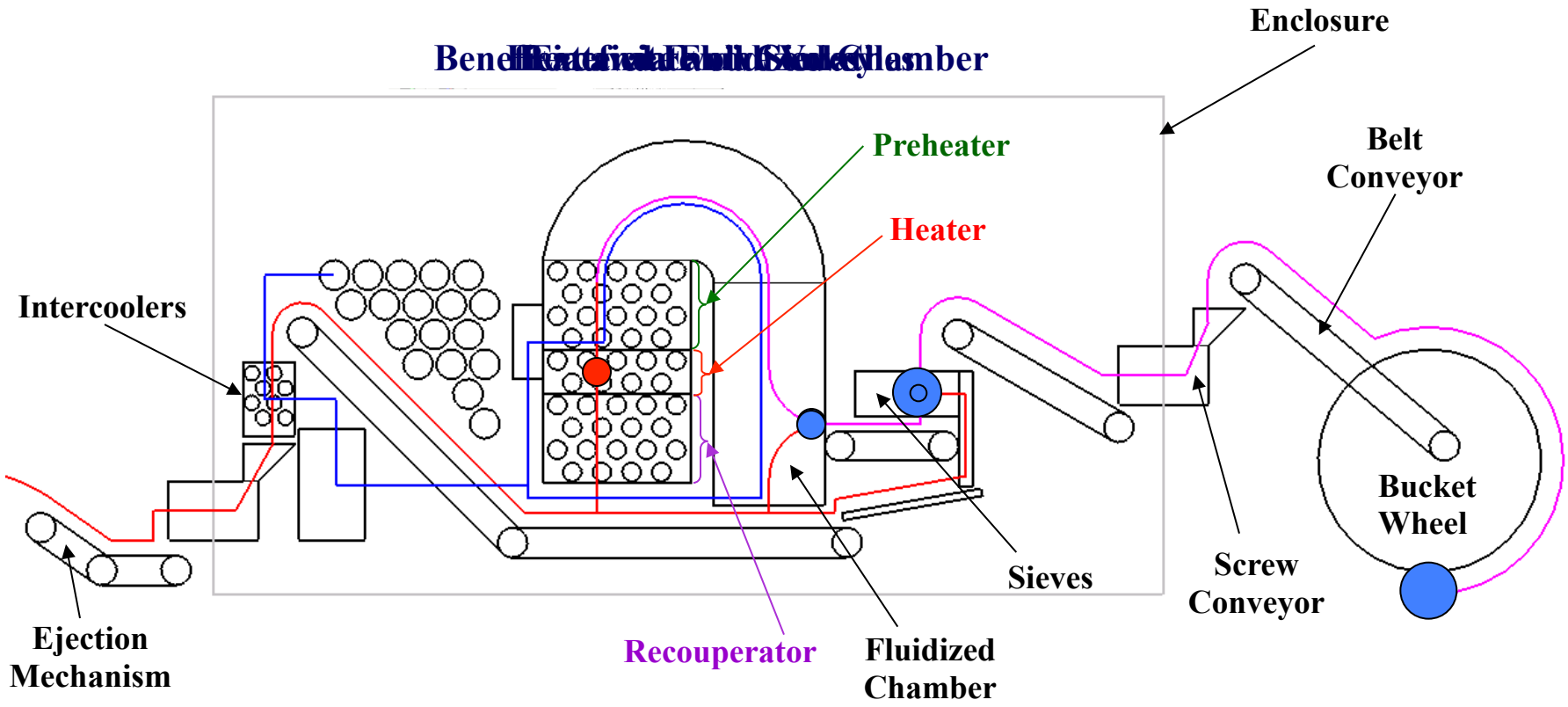
- Only designed the miner
- Same processing capabilities as Mark II
- Empty Mass: < 10 tonnes
- Gas loss: < 10%
- Base camp maximum of 10 km away
- Can drive on 20º side-slope

Mark III Components*

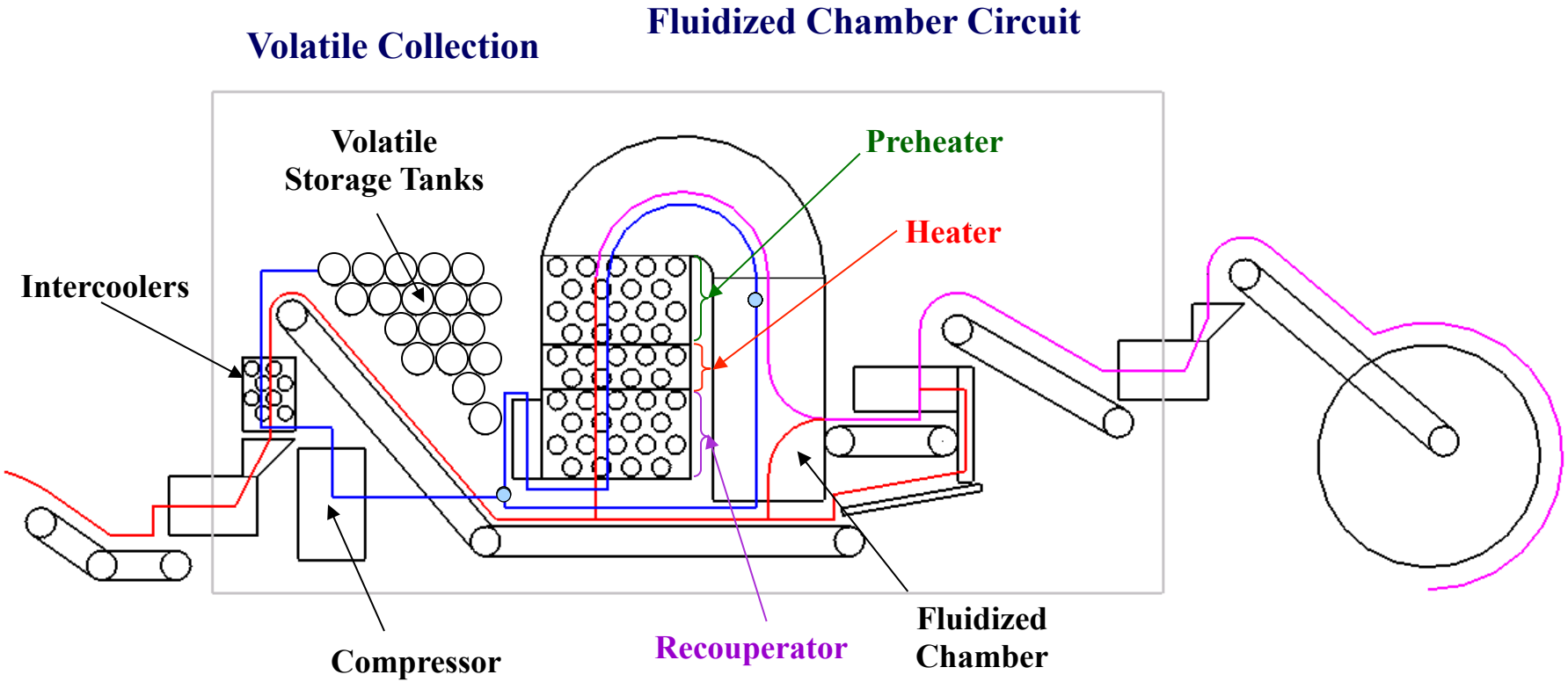


*Enclosure, solar collector, and RF rectenna not shown

Regolith Flow Schematic

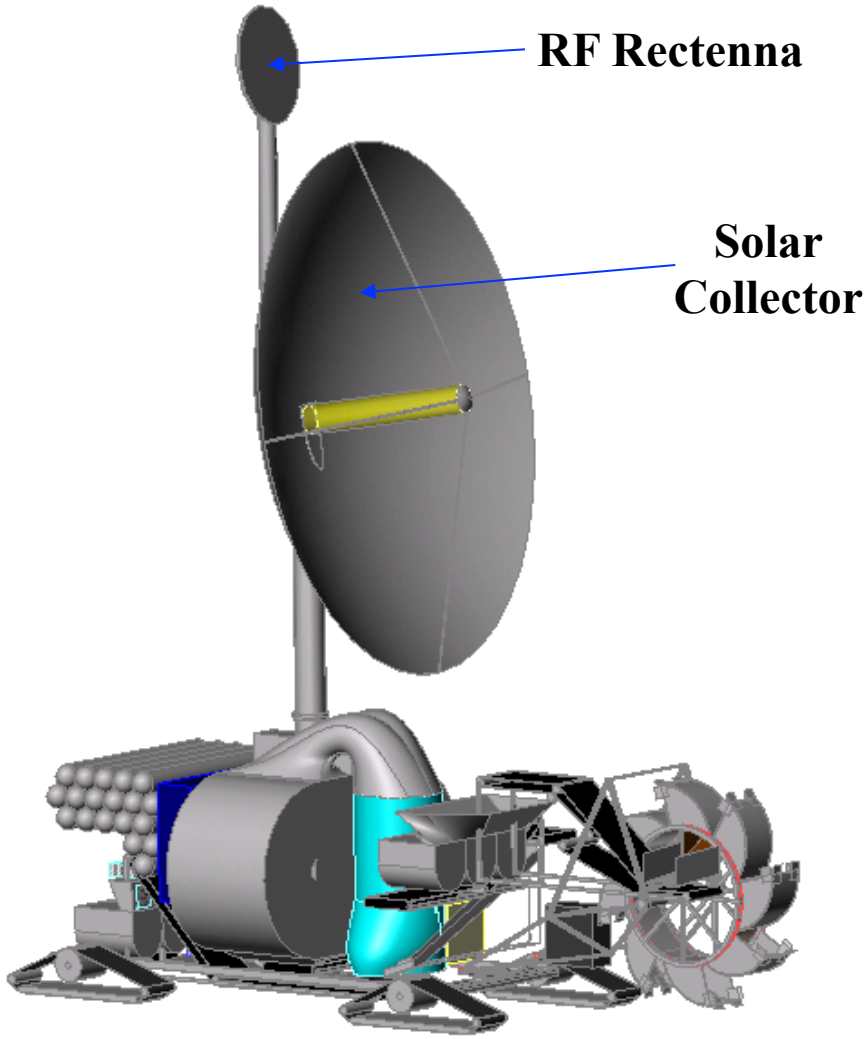


Volatile Flow Schematic



Energy Overview

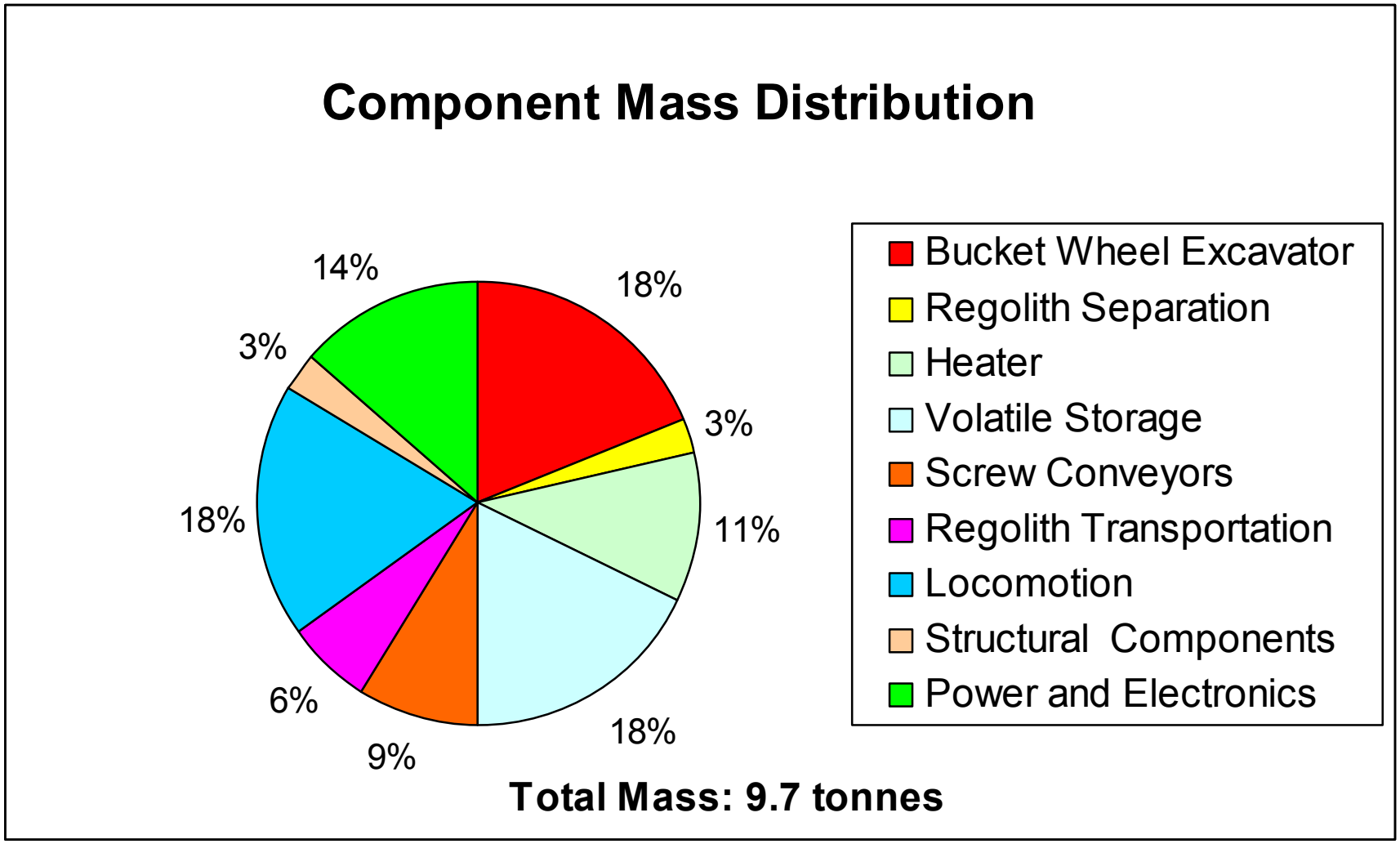
- Regolith Heater energy
  - Beamed concentrated solar energy
  - 12.3 MW thermal
- Miner Electric power
  - Beamed radio frequency (RF) waves
  - Overall RF conversion efficiency ~50%



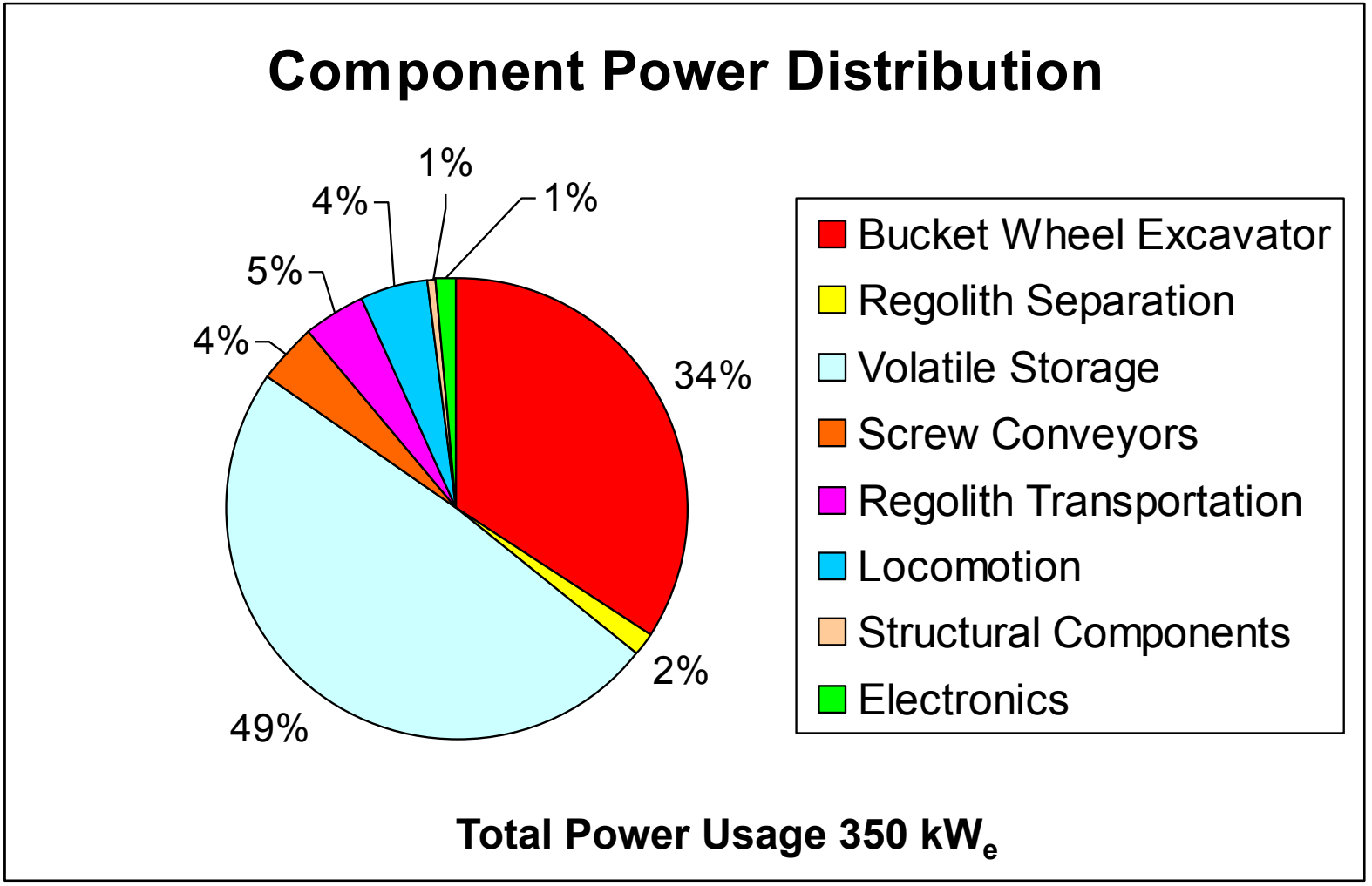
Results

- Gas loss: 9.9%
- Can handle 30° side-slope
- Size:
  - Length: 13.5 m
  - Width: 5.4 m
  - Height: 4.9 m
- Mass: 9.7 tonnes
- Power Usage: 350 kW_e

Mass Evenly Distributed



Volatile Storage Dominates Power Usage



Mark III Compared to Mark II

	Mark II	**Mark III**
Internal Pressure	0.1 MPa	0.015 MPa
Gas Storage Tank Pressure	15 MPa	20 MPa
Size	19.7 m × 10 m × 10 m	13.5 m × 5.4 m × 4.9 m
Mass	18 tonnes	9.7 tonnes
Electrical Power Usage	200 kW_e	350 kW_e

Conclusion

- Cut the mass by nearly half
- Retained capabilities of Mark II
- Categorized mass and power
- Identified areas of improvement

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Questions?