

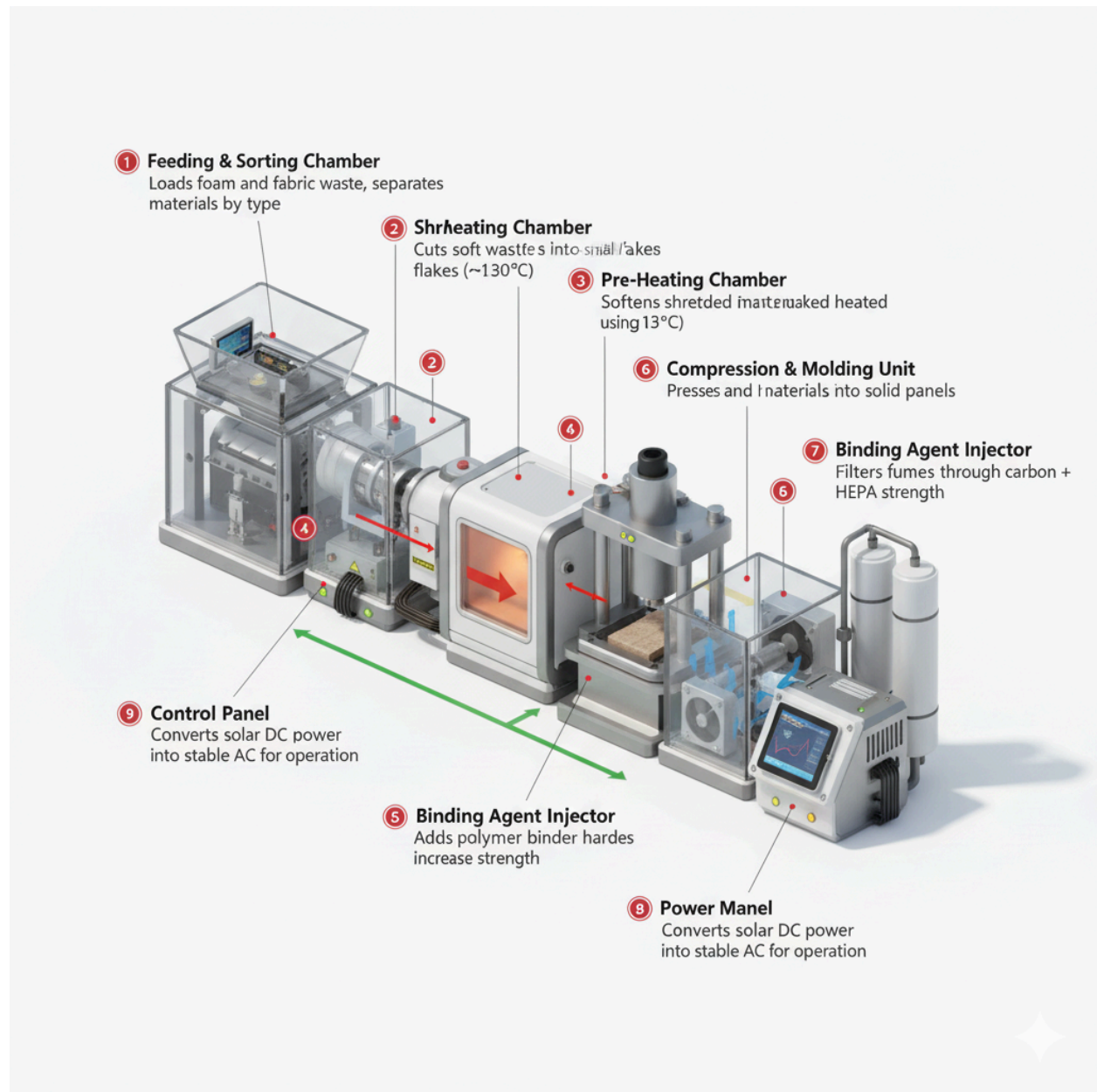
FOAM & FABRIC RECYCLING SYSTEM (FFRS)

(Designed for NASA Mars Mission – Soft Waste Reuse & Habitat Sustainability)

2. System Overview

Parameter	Description
Machine Name	Foam & Fabric Recycling System (FFRS)
Main Function	Recycles soft materials (foam, textiles, insulation) into reusable solid panels.
Operation	Semi-automatic, heat-based compression and air-cooling system.
Power Need	~1.5–1.8 kW average
Output	~0.8 kg of recycled material per hour
Cooling Method	Air-cool solidification (no water use)

3. Machine Components and Functions



Component	Function
1 Feeding & Sorting Chamber	Loads foam and fabric waste; sensors separate material types.
2 Shredding Drum	Cuts soft waste into small flakes for heating.
3 Pre-Heating Chamber	Heat flakes (120–150 °C) to soften fibers.
4 Compression & Molding Unit	Hydraulic press fuses material into solid blocks or panels.
5 Cooling & Solidification Chamber	Air-cools and hardens the compressed blocks.
6 Binding Agent Injector	Adds bio-polymer resin to increase strength and durability.
7 Gas Filtration Unit	Filters fumes through HEPA and carbon filters.
8 Control Panel	Displays temperature, pressure & cycle status.
9 Power Module	Converts DC solar input to AC power for heaters and motors.

4. Process Flow

Foam & Fabric Recycling System – Component Breakdown (Mars Mission Use)



Step 1: Foam and fabric waste are loaded and automatically sorted by sensor.

Step 2: Materials are shredded into fine flakes.

Step 3: Flakes enter the pre-heating chamber and soften under

controlled heat.

Step 4: The softened mass is compressed and molded into solid blocks.

Step 5: Air cooling chamber solidifies and stabilizes the output.

Step 6: Filtered exhaust removes fumes safely for crew environment.

5. Features for Mars Environment

Mars Challenge	Design Adaptation
Low atmospheric pressure & limited heat transfer	Thermally insulated chambers and precise heat control.
No liquid water available for cooling	Air-cooled solidification system.
Fine dust & air contamination	Fully sealed body with gas filters.
Crew health and safety	Low emission, automatic shutdown system.
Limited energy supply	Efficient heating elements + solar powered converter.

6. Impact & Benefits

- Enables reuse of insulation and soft materials directly on Mars.
- Supports habitat renovation & repair using recycled panels.
- Reduces waste volume and storage needs.
- Minimizes Earth resupply and launch mass.
- Enhances crew self-sufficiency and sustainability.

7. NASA References

- ① **Waste Materials Recycling for In-Space Manufacturing** – NASA Technical Report (2018)
- ② **Waste Management Options for Long-Duration Space Missions** – NASA (2005)
- ③ **Dual Use of Packaging on the Moon (Logistics-to-Living)** – NASA (2020)

8. Future Integration

This Foam & Fabric module will integrate with the **Plastic and Metal Recycling systems**

to form the **Tri-Phase Modular Recycler (TPMR)** —
a unified recycling network capable of processing **metal, polymer, and composite waste**
for a fully sustainable Mars colony.