NASA API Usage in the M-REGS Project

1. Solar Energy Forecasting

- We integrated the **NASA POWER API (Prediction Of Worldwide Energy Resources)**, which provides solar radiation and weather datasets.
- Parameters used:
    - **ALLSKY_KWH** (daily solar insolation in kWh/m²/day).
    - **T2M** (air temperature) and **RH2M** (relative humidity) for refining efficiency assumptions.
- Purpose:
    - To calculate **daily solar energy availability** for the solar panel subsystem.
    - Allowed us to estimate **how much of the system's energy demand can be met by solar vs. SOFC**.
- Implementation:
    - API call queried by **latitude/longitude** (e.g., Dhaka: lat=23.81, lon=90.41; Mars habitat: simulated lat/lon from NASA's mission datasets).
    - Output was displayed dynamically in the dashboard as **"Solar from NASA API"** in both numbers and bar charts.

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2. Days Projection Slider

- With the **days projection tool** in the dashboard, we multiplied solar generation values by the number of days selected.
- Example:
    - 20 kWh/day from NASA API × 10 days = **200 kWh projected solar**.

- This allowed users to visualize how the system behaves over time under **real-world solar conditions** instead of static assumptions.

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3. Location-Specific Adaptation

- NASA API queries were **location-based**, making the system portable and adaptable.
- For Dhaka:
    - Pulled **daily solar insolation values** for Bangladesh to design solar panels that match local weather.
- For Mars:
    - Though POWER API does not directly cover Mars, the **integration framework** was designed so that when NASA publishes Martian insolation datasets, M-REGS can connect seamlessly.
- Dashboard Enhancement:
    - A **"Change Location"** button was added to let users input coordinates (or city for Earth).
    - This re-fetches API data dynamically, instantly adjusting the solar generation numbers.

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4. Self-Sufficiency Calculations

- The energy self-sufficiency metric depended on three contributors:
    - Solar energy (NASA API)
    - SOFC output (from waste pyrolysis gases)
    - Thermal energy reuse
- By plugging in NASA's real-world solar values, we could **accurately compute % self-sufficiency** instead of assuming fixed solar inputs.

- This gave decision-makers a **true picture of how sustainable the system is in different environments**.

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5. Sustainability Dashboard Outputs

- NASA API data directly influenced:
    - **Projected solar kWh/day** (numeric + graph).
    - **Energy summary bar chart** (Solar, SOFC, Thermal).
    - **Energy self-sufficiency %** (dynamic recalculation each time solar data changed).
- This ensured the dashboard was not just a simulation, but a **data-driven tool tied to real-world atmospheric conditions**.

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6. Creative Use of NASA API

- Beyond just raw solar values, our team used the API creatively to:
    - **Compare different deployment sites** (Dhaka vs. deserts vs. potential Martian equivalents).
    - Simulate **seasonal variations in solar generation** for Earth-based deployments.
    - Prepare the system for **future NASA Mars datasets**, so the Dhaka dashboard could be repurposed for Martian base planning.
