(Microreactor Applications Research, Validation & EvaLuation),
2023

Microreactor Applications

Sponsored by DOE-NE 5

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INL Idaho National Laboratory | Oak Ridge National Laboratory | MRP Microreactor Program | Los Alamos National Laboratory | Argonne National Laboratory

Project Status & Challenges

- **Final Design Phase:**
  - The final design review was held in September 2022
  - Team addressing comments with resolutions
  - Finalizing 250+ engineering deliverables to complete final design per DOE-STD-1189
    - Challenge: The project is severely resource-constrained
- **Procurement of Long Lead components:**
  - Fabrication quotes received from vendors and contracts awarded for fabrication
  - DOE authorized MARVEL to purchase long-lead materials
  - The project intends to initiate key SSC fabrication by the Spring of this year, pending DOE approval
    - Challenge: materials lead time has multiplied by a factor of 2 to 4, extending the schedule
- **Fuel Delivery:**
  - Fuel contracts have been challenging
  - Currently fuel delivery is the critical path for MARVEL
    - Challenge: Delays in three fuel contracts have removed most of our scheduled float

MRP Microreactor Program

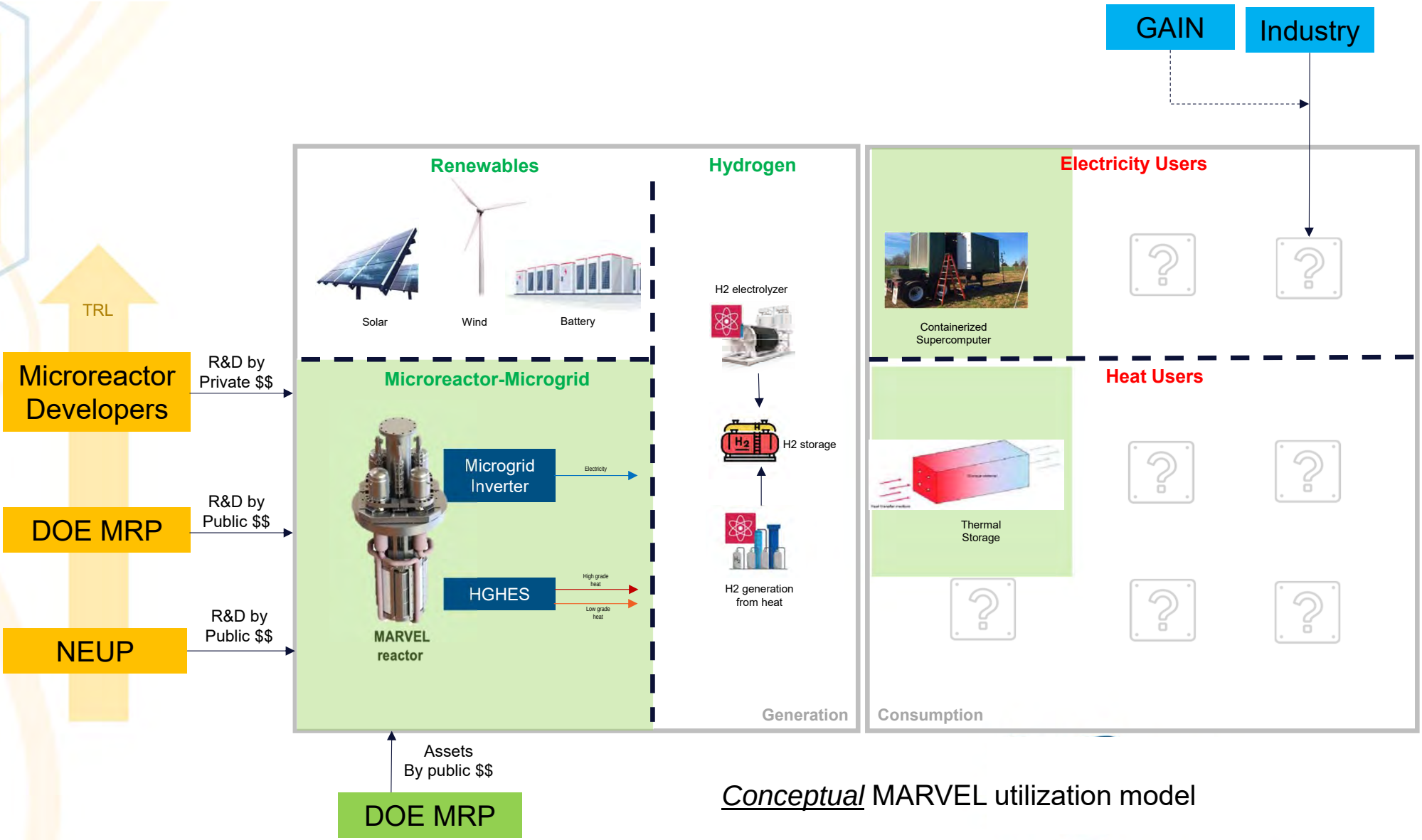
Remainder Technical Challenges

- **Stirling Engines**
  - No longer “off-the-shelf
  - Haynes heat exchanger tubes are not chemically compatible with lead, need replaced with SS316
  - Multiple internal components are not rad-hardened and need to be replaced
    - Challenge: Additional lead times are needed for rad-hardened components
- **Radiation Shielding**
  - Due to its compact design, there is little room for shielding sensitive components
  - Difficult to procure high TRL, low-cost, high-temperature shielding
    - Challenge: some key components need replacement over time
- **Intermediate Heat Exchangers**
  - Difficult to procure high-purity lead
  - Bismuth impurity leads to traces of activation products like Po-210
  - Lead oxygen control is tricky, finalizing solution design
    - Challenge: practical resolution delayed final design completion

Nonetheless, the MARVEL project’s strength is to resolve difficult challenges quickly and will innovate resolutions prior to fabrication-construction

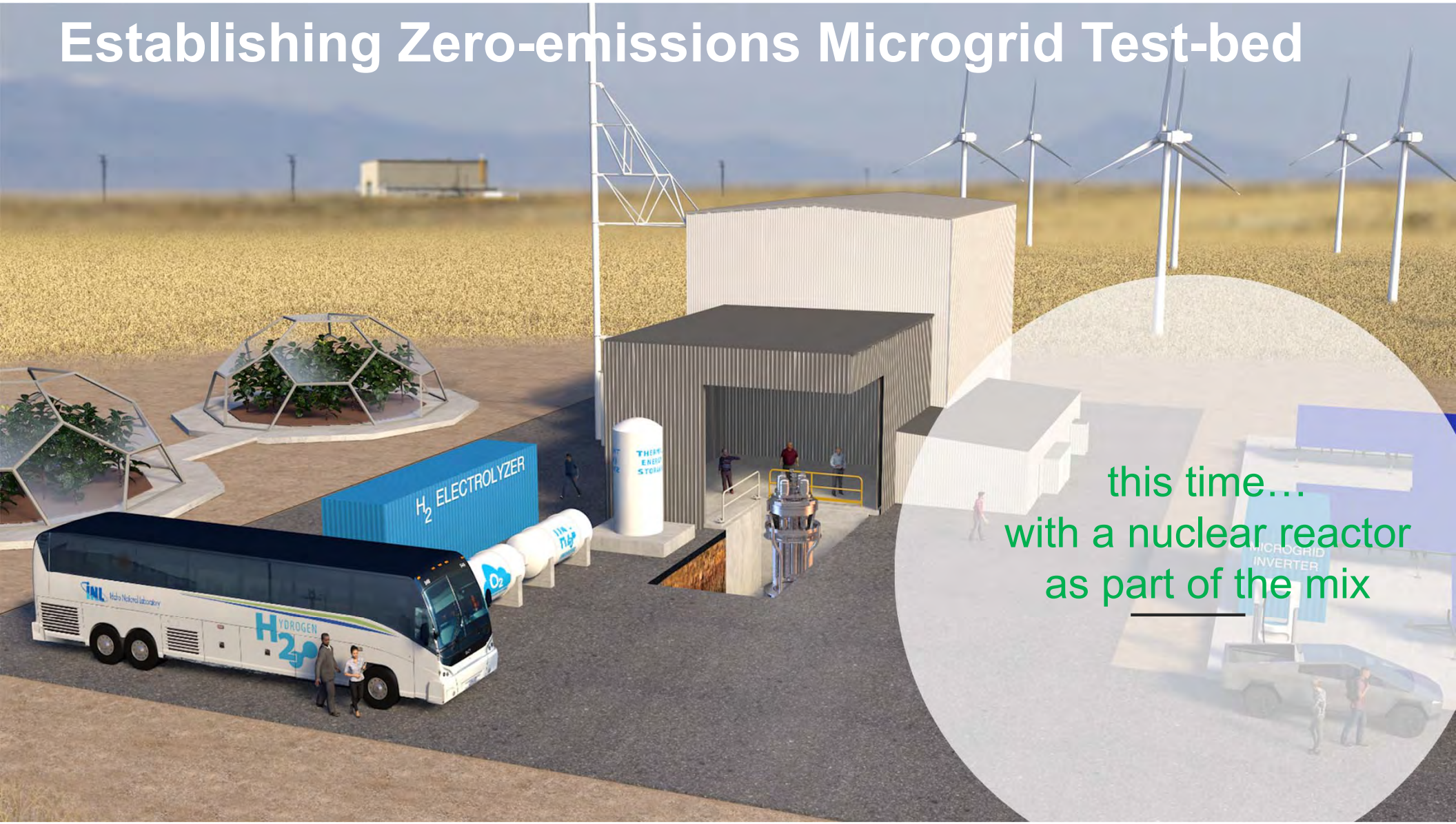
MRP Microreactor Program

MARVEL plans to:
Complete Construction by Spring 2024
load fuel by end of 2024

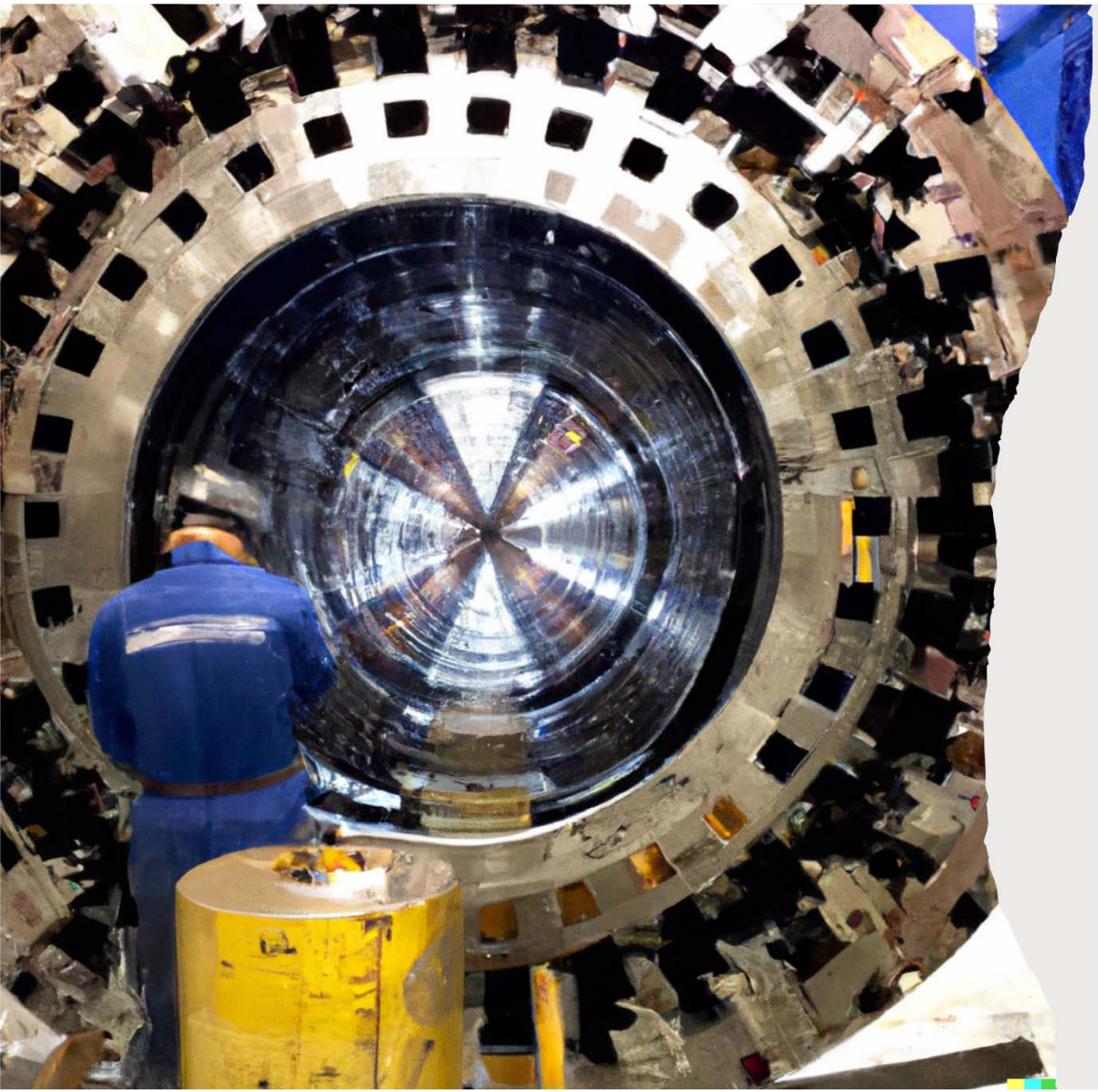


Conceptual MARVEL utilization model

Establishing Zero-emissions Microgrid Test-bed



this time…
with a nuclear reactor
as part of the mix



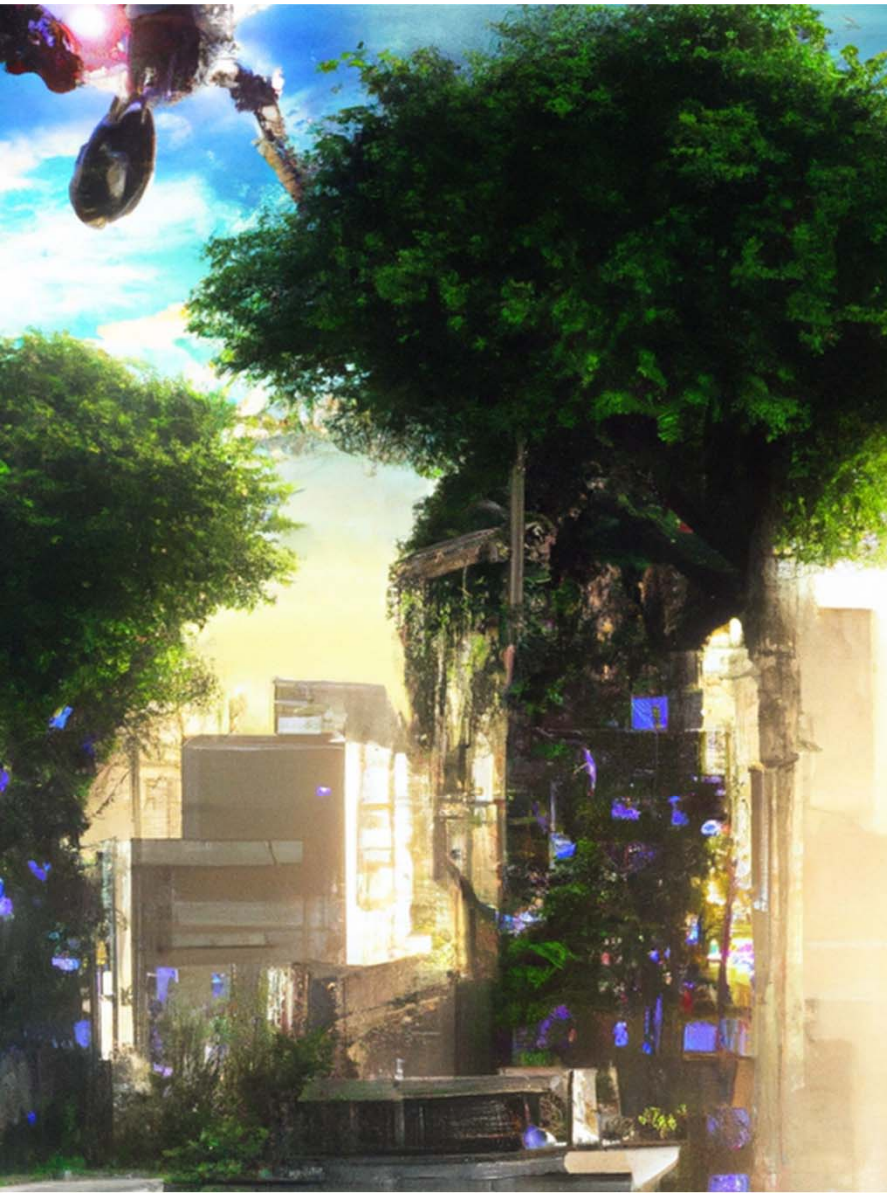
Wrap Up

Building a nuclear reactor isn't easy,

- but with a great team, a supportive regulatory body, we will be successful

Outcomes:

- Critical lessons learned all the way through startup→ translate to industry
- Test Semi-Autonomous control systems
- Overcome regulatory barriers
- Enable a new test reactor capability, focused on end-user applications



" "Small but Mighty: Unlocking a New Era of Energy with Microreactors"

- ChatGPT

Thank You