Retrofitting a Diesel System in Stages

Peter Lilienthal, Ph.D.
Founder, HOMER Energy
Global Microgrid Lead, UL

July 26, 2022

4 Kinds of Hybrid Systems

1. Energy access village power
    - Tiny greenfield projects
    - HOMER Pro
2. **Island diesel power system**
    - **Retrofit with renewables**
    - **HOMER Pro**
3. Grid-connected distributed power
    - Resilience, carbon footprint, & demand limiting
    - HOMER Grid
4. Utility-scale, front of the meter
    a. Increasing capacity factor of interconnections
    b. HOMER Front

Existing Diesel Systems

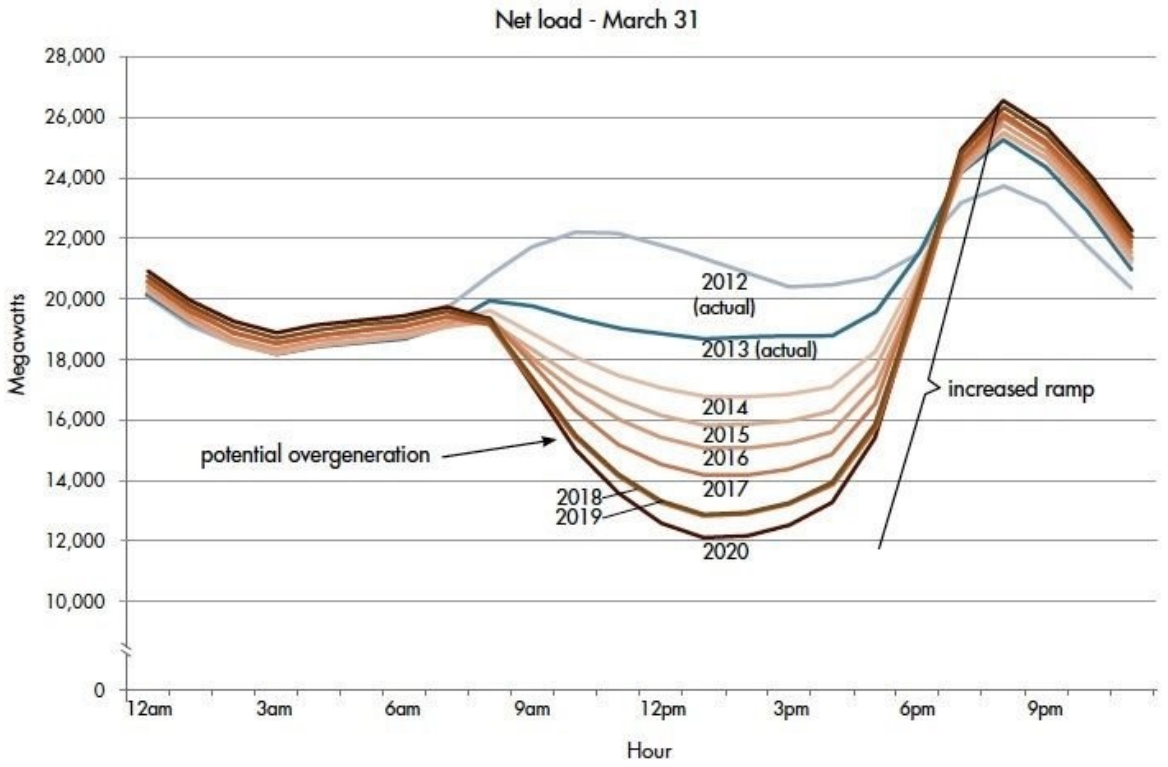
- What is there now?
  - Condition
  - Oversized diesels
  - Multiple diesels
    - Identical or different sizes
    - Synchronization?
  - Controls
  - Heat recovery

Taxonomy

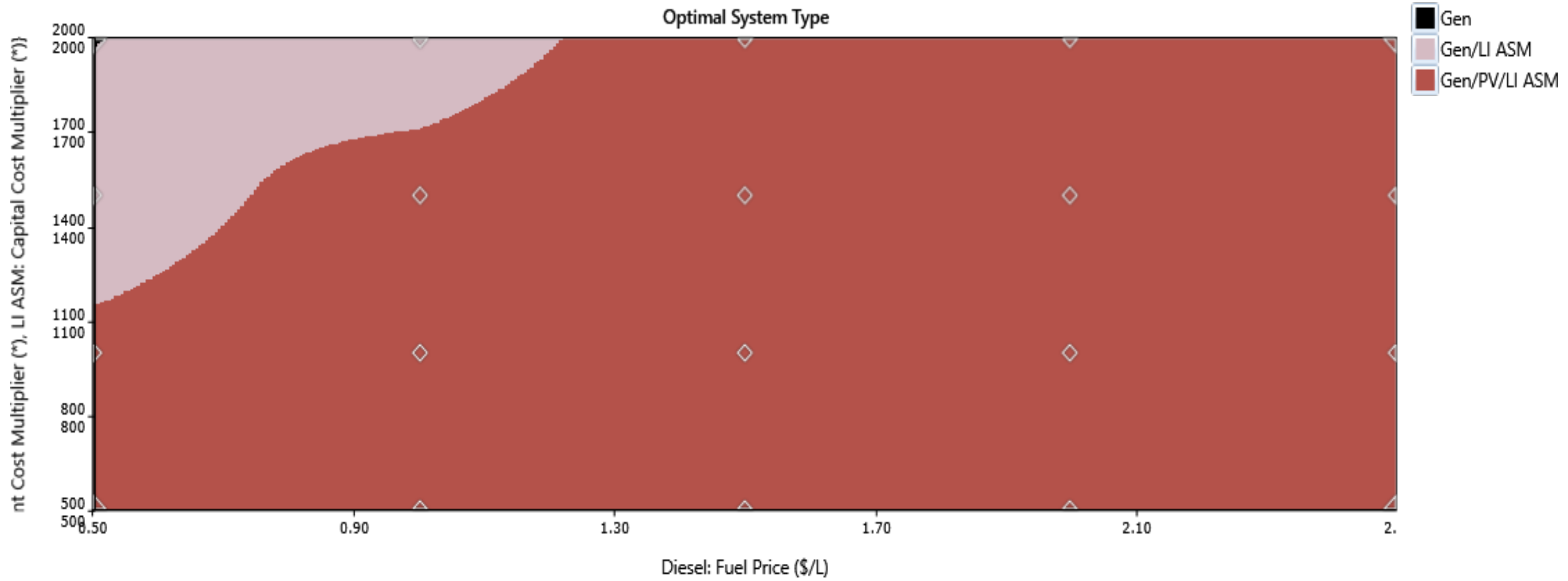
	No storage	Storage
Diesel must run	Low penetration “Fuel saver”	Medium Penetration
Diesel off	NA	High Penetration

5 Stages of Renewable Penetration

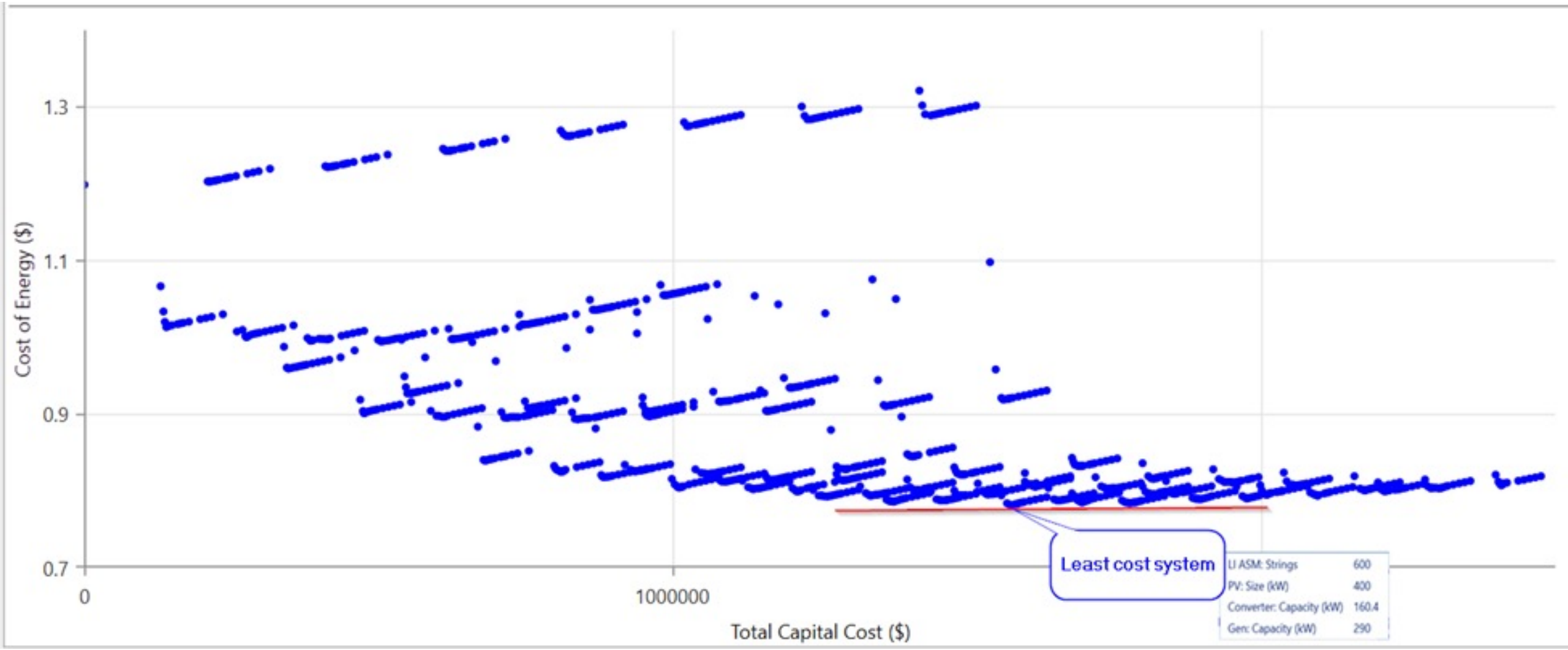
1. Simple fuel savers
   - No storage
2. Storage for frequency stability
   - Power batteries, flywheels, supercapacitors
3. Storage for spinning reserve and altering commitment schedules
   - Minimum loading issues
   - < 1-hour batteries
4. Multi-hour storage for energy shifting
   - 4-hour batteries
   - Duck curve
5. Very high penetration systems
   - Long duration storage



Solar cost-effective above Arctic Circle even @ $2.50/watt

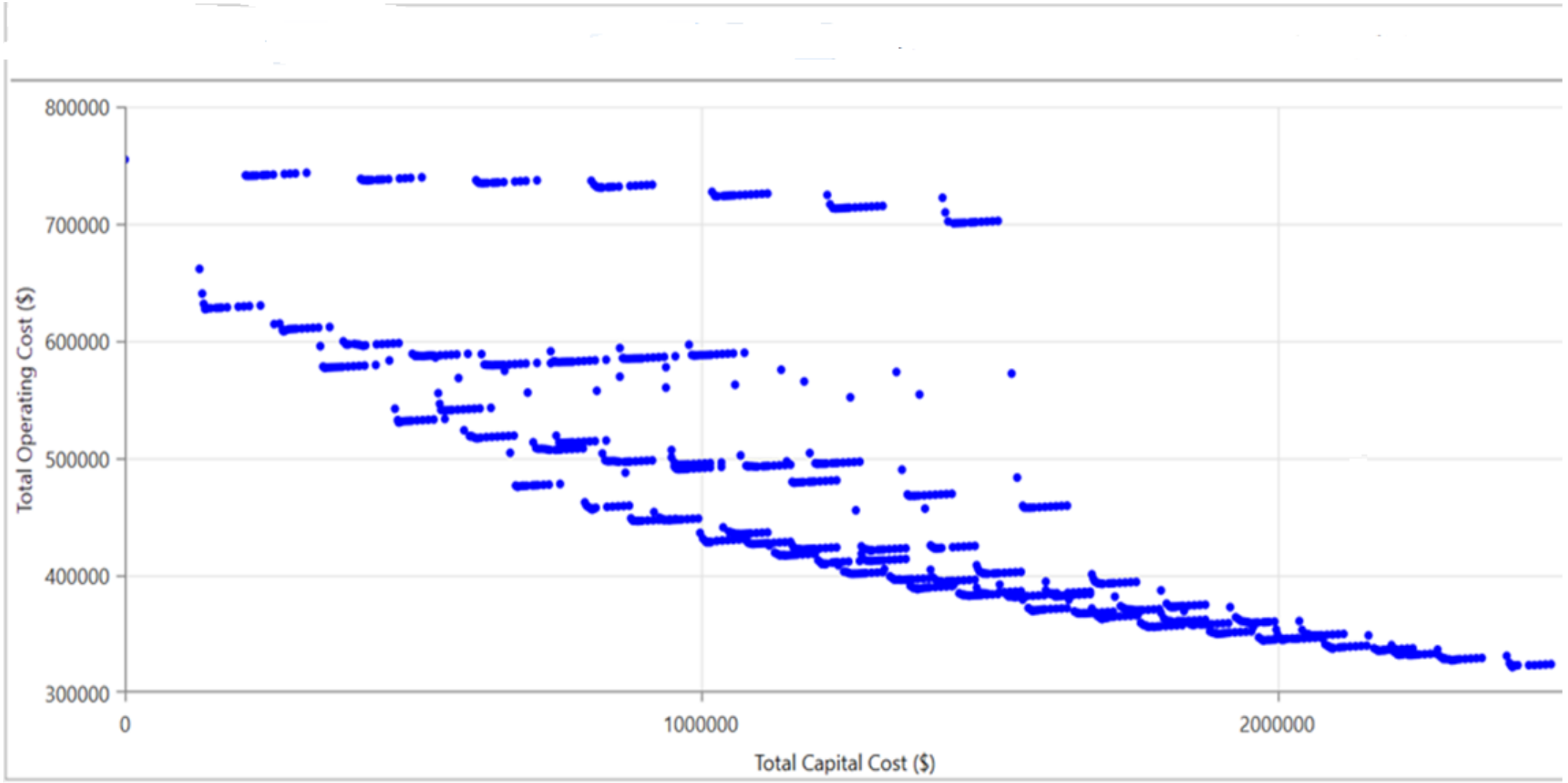


HOMER Results



Solar + Storage above Arctic Circle, $2/watt solar, $9.50/gallon fuel

Reducing Fuel Usage

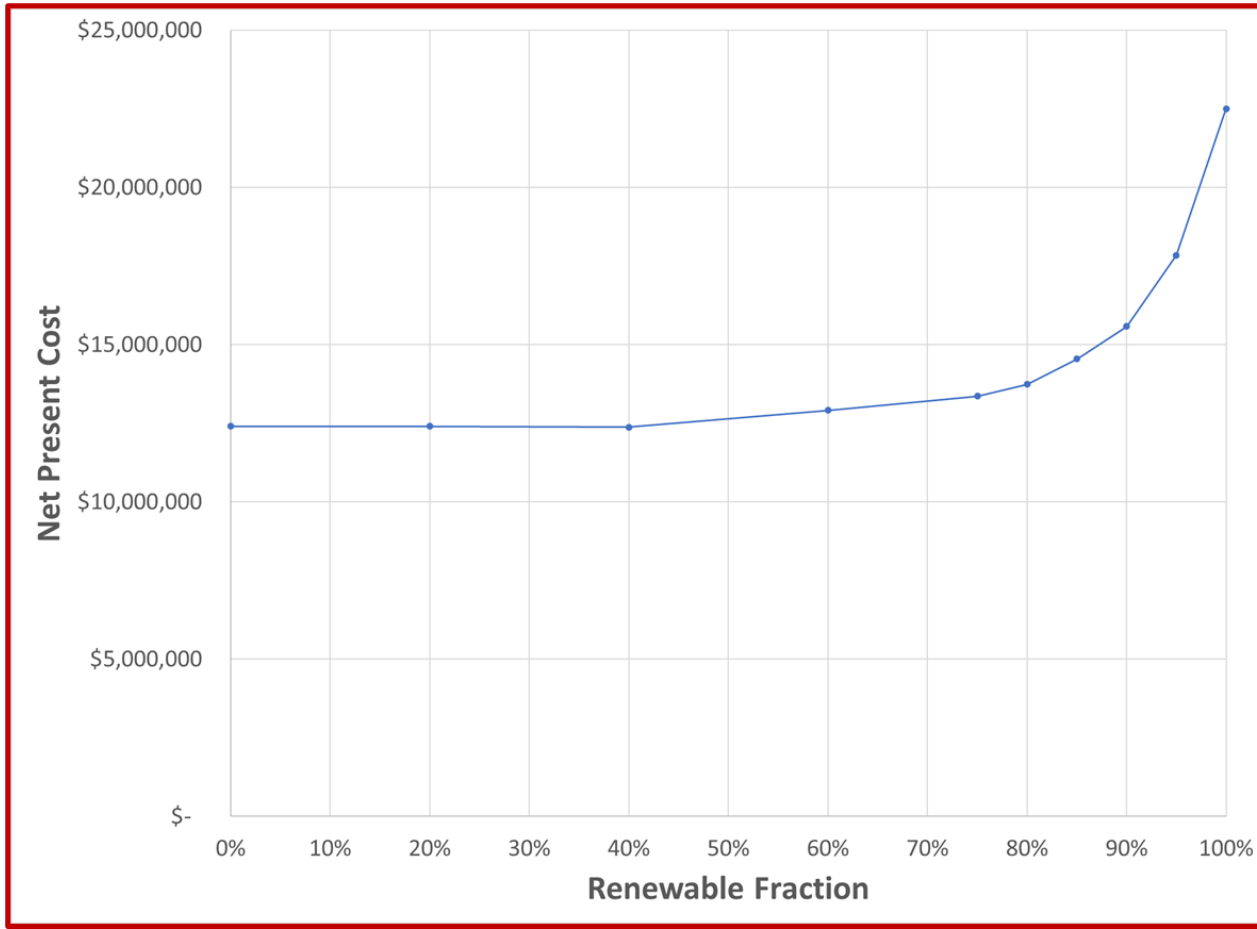


Long Duration Storage

- Flow batteries
- Load management with thermal storage
- Hydrogen
- How many cycles per year?

100% Renewable?

- This is a distracting question
  - The perfect is the enemy of the good
- Potential solutions to last 10% problem
- Demand management
- Biofuels
- Hydrogen



Conclusion

- Architecture depends on RE penetration
- Solar is surprisingly cost-effective, even in Alaska
- Wind leads to higher RE penetrations
- Interplay between diesel and storage is the key
- Diesel-off is the goal