EVERBESS: END OF LIFE CONSIDERATIONS FOR BATTERY ENERGY STORAGE SYSTEMS

Jakob Elias (1), Aravind Baby (1), Qiang Dai (1)
(1) Applied Materials Division, Argonne National Laboratory

PROJECT PROFILE

Topic: Analytics & Tools | Vertical: Materials and Systems Innovation
Strategic Pathway: Grow
Project Start and Finish: FY22-Present

PROBLEM

Deployment of battery energy storage systems (BESS) is rapidly increasing to serve the explosive growth in energy demand. This necessitates a better understanding of end-of-life (EOL) management at planning stage. Currently:

- Most BESS owners have a poor understanding of EOL management
- Certain BESS chemistries could even have negative EOL value
- Stakeholders and the industry desire more clarity on component fates and better-informed estimates of the anticipated costs at EOL.

EverBESS is a modeling tool that assesses the economic impacts associated with EOL BESS management with a user-friendly framework that considers the decommissioning, transportation, and recycling of the entire BESS as part of EOL considerations.

- Improve cost and environmental impacts over the life cycle of BESSs
- Provide better decision making in the planning and design stages
- Promote awareness of potential EOL options to improve material use and circularity

APPROACH

Decommissioning
- De-energizing
- Disconnection and covering of module electrodes
- Removal and packaging of modules
- Removal of all other system components
- Site cleanup

Transportation
- Transport of modules to a capable recycler
- Transport of other system components to a scrap yard or resale
- Hazardous material requirements may apply

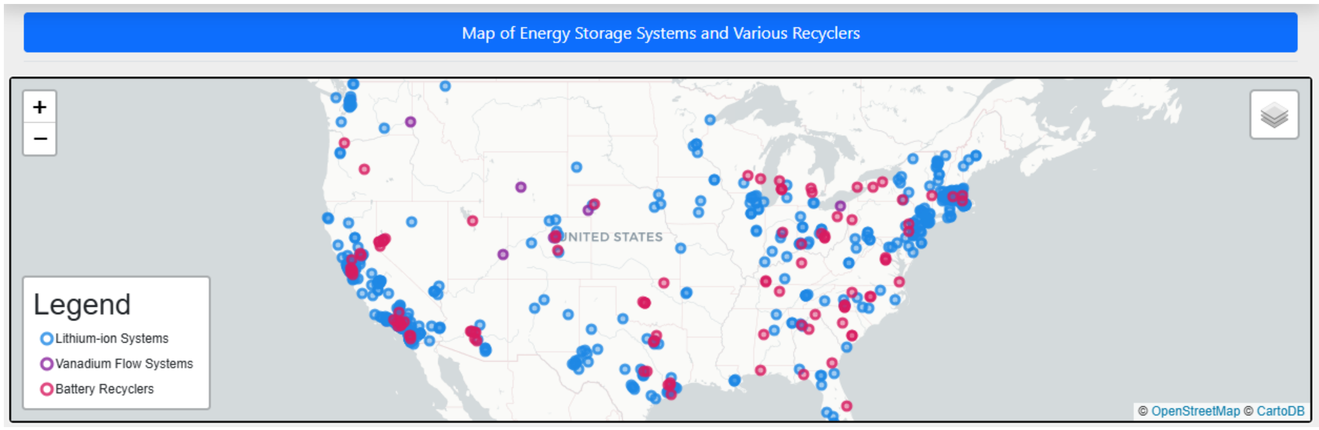
Recycling
- Battery modules disassembly and/or size reduction
- Recovery of critical minerals and metals from batteries
- Recycle non-battery components

- EOL management is divided into three distinct stages: decommissioning, transportation, and recycling
- Considers multiple lithium-ion battery chemistries and vanadium-redox flow battery technologies with sodium-ion coming soon
- Select one or more recyclers to model different fates for various system components
- EverBESS auto-calculates distances and transportation details
- Highly customizable model inputs that allows users to adjust all major modeling assumptions (material prices/revenues, labor, transportation, utility costs, etc.)
- Model API for programmatic integration with other applications
- MCP server for use in agentic AI systems

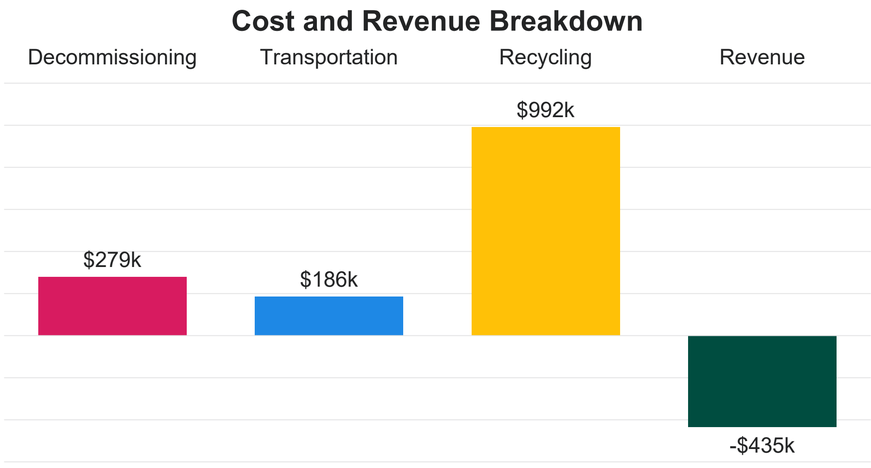
FUTURE DIRECTIONS

- EverBESS can help improve life-cycle cost and reuse potential for the variety of components used in BESSs and advance efficient use of materials.
- API and MCP support positions EverBESS to be leveraged more effectively by industry and future R&D efforts
- Next steps in EverBESS recycling process development
  - Continue testing and validation of results against real-life BESS decommissioning data
  - Evaluate accuracy of VRFB recycling and refine VRFB refurbishing process models
  - Incorporate process modeling results of Na-ion batteries into the online platform
  - Examine uses EverBESS to improve the understanding of levelized cost of energy storage (LCOS) over the complete lifecycle of a BESS

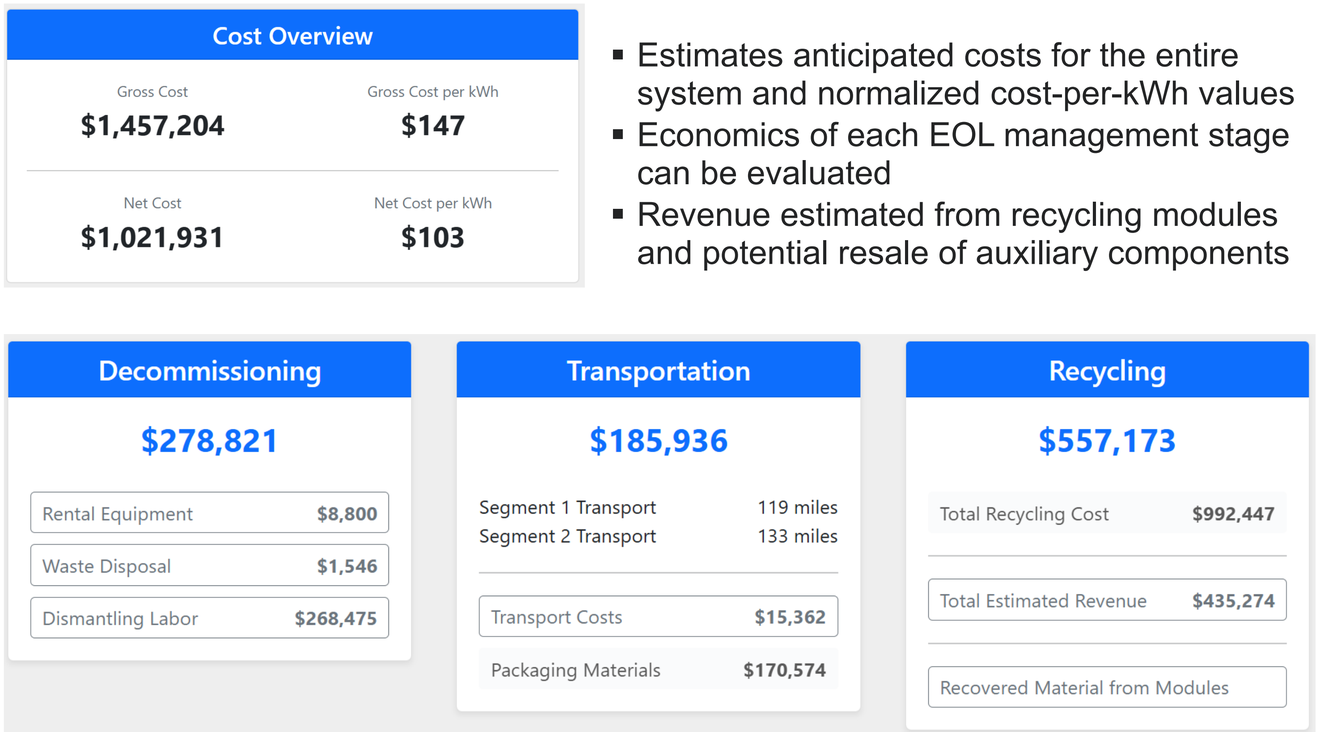
RESULTS



EverBESS allows users to select known energy storage systems and recycling facilities in the U.S. to determine the EOL component fates and anticipated costs. Users may also define their own custom BESS or recycling facility to create EOL management scenarios.



Try EverBESS!



- Estimates anticipated costs for the entire system and normalized cost-per-kWh values
- Economics of each EOL management stage can be evaluated
- Revenue estimated from recycling modules and potential resale of auxiliary components

*Example results from a 10 MWh BESS with LFP chemistry battery modules

CONCLUSIONS & IMPACT

- Comprehensive framework for a holistic look at all EOL management steps for battery and non-battery components
- Assist in the creation of data-informed EOL management plans
- Identify major pain points and process improvement opportunities over all stages of EOL management
- Help identify sites for new BESS deployments and recycling plants
- Identify resale or reuse opportunities for common components in BESSs and potentially other energy storage technologies
- Informing R&D about economical BESS technologies
- Expanding potential to proactively assess new and upcoming BESS technologies

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