Reducing the Costs of Manufacturing Flow Batteries

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Motivation

- Economics are currently a major challenge for energy storage technologies.
- Flow batteries have the potential to be a game-changer as they decouple storage capacity and power generation.
- Design and material cost reductions are a means to reducing battery costs.
- Is it possible to accelerate the knowledge building that comes from building at scale and use it now, when manufacturing at scale is just getting started?
- Can we use the fuel cell experience and other manufacturing processes to help answer this question?

Project Objectives

Determine means to reduce costs in the flow battery manufacturing process by increasing efficiency and using techniques to:

- Address bottlenecks in processes
- Reduce equipment costs
- Reduce energy use
- Reduce material use

Study Progress

- Surveys and site visits have been complete for a few manufacturers
- Initial determination of manufacturing issues and pinch points established.

Initial Survey Results

General Manufacturing Issues

- Costs are high: $1000/kWh for battery and BOP (without inverters) -> Component costs are the main driver
- Manufacturers are currently (largely) in the development and prototype phase
- System design is of greatest importance until volumes exceed 50 MW/year

Production Issues

- Electrodes and separator manufacture are time/cost pinch points
- Electrolyte production are a time/cost pinch point
- Process: 60% assembly, 40% manufacture
- Automation is very limited
- Equipment: Some custom equipment, some new OTS, some repurposed
- Manufacturers have conducted some work on material and labor efficiency based on their current designs

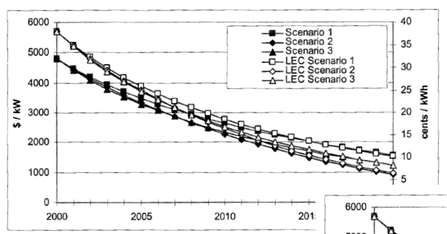

Figure 3: Projected world average solar photovoltaic capital cost scenarios.[3, 4]

Kobos, P. et al. "Technological learning and renewable energy costs: implications for US renewable energy policy". *Energy Policy* 2006

Estimating cost reductions with 2-factor experience curves

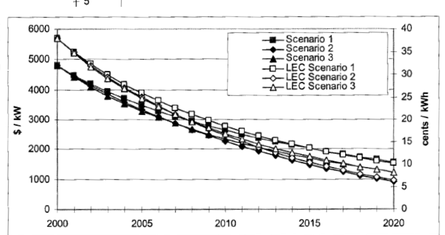

Figure 3: Projected world average solar photovoltaic capital cost ($/kW) and LEC cost (cents/kWh) scenarios.[3, 4]

Study Methodology

- Manufacturer survey & site visits: evaluate current manufacturing processes for different flow battery types.
- Determine pinch points and high cost processes.
- Evaluate means to address these issues based on
  - Fuel cell manufacturing experience
  - Manufacturing processes for established battery technologies
  - Manufacturing processes from the technology, and chemical industries
- Estimate the possible reduction in costs through a process using learning and knowledge projections

Next Steps

1. Continued outreach with other with other manufacturers
2. Characterization of the flow battery manufacturing process and determination of process issues
3. Evaluation of the fuel cell, other battery and other industry manufacturing process to address issues identified
4. Coordination with PNNL flow battery component cost modeling work and Sandia flow battery research staff
5. Final report discussing the current state of flow battery manufacturing and future expectations.