

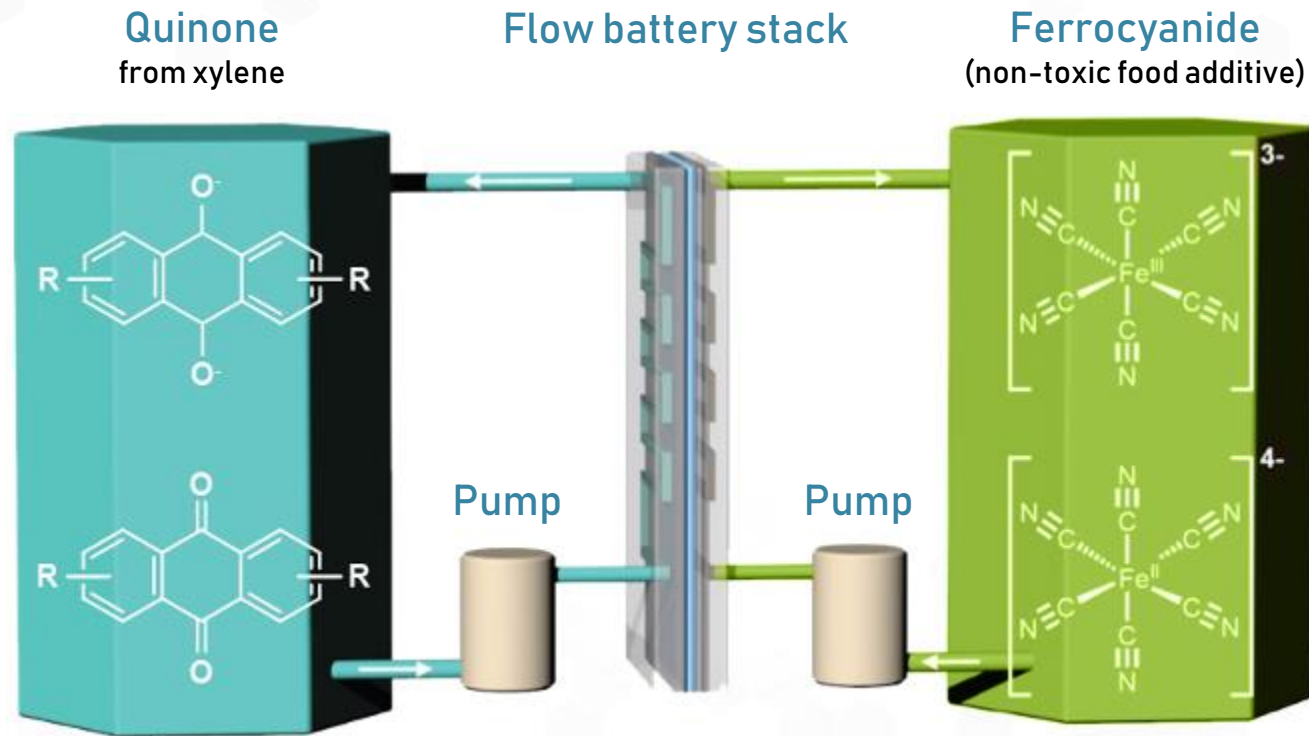


# Low Cost, Fast-Scaling Organic Flow Batteries Enabled by a Zero-Waste, Continuous Flow Electrochemical Production Process

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# Quino Energy Makes Organic Flow Batteries

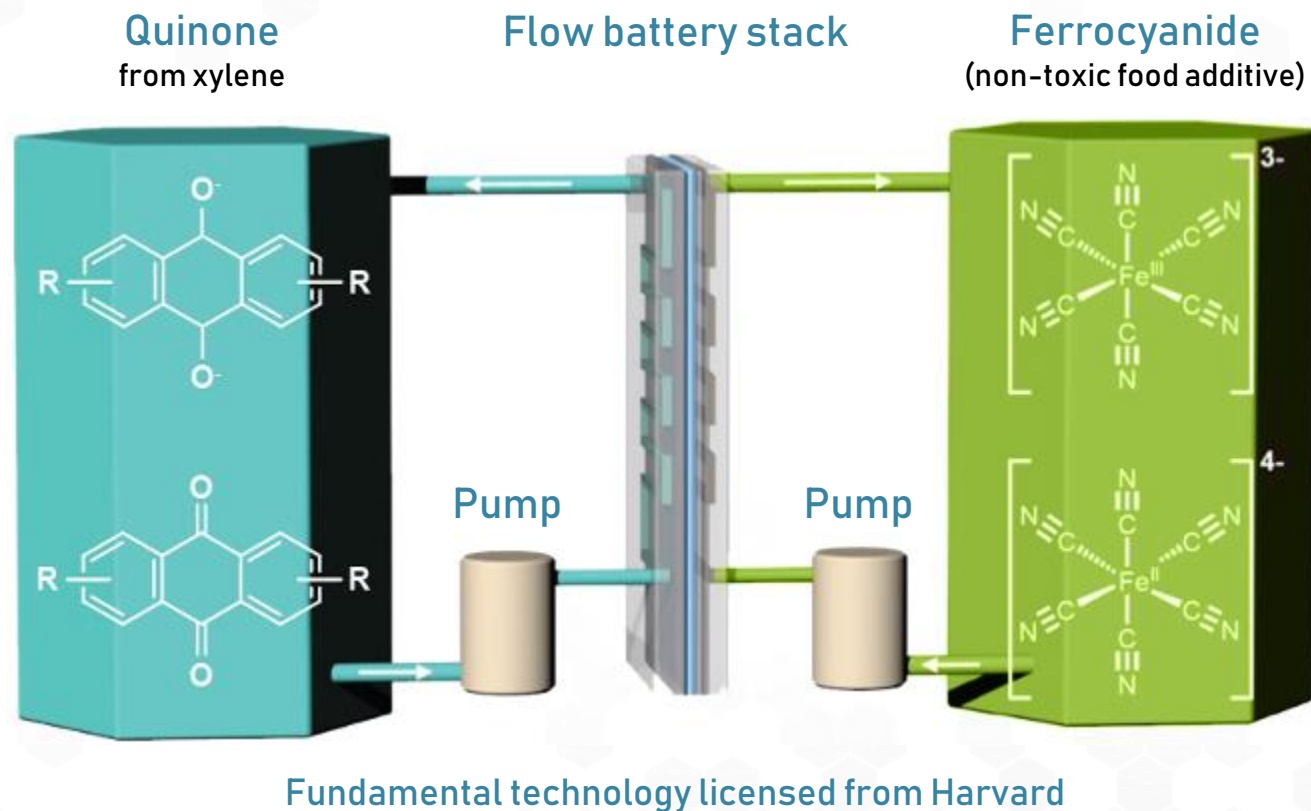


Fundamental technology licensed from Harvard

Our water-based quinone battery is:

- 30-40% cheaper than LFP with 10x slower degradation,
- with a 3x smaller footprint,
- doesn't catch fire, and
- is Made in USA with no critical or PFAS materials.

# Quino Energy's Chemistry Leverages Existing Hardware



- Uses vanadium flow battery hardware with minimal modification
- Vanadium is replaced by an organic reactant that is 1/4 the cost and much more abundant
- The upstream raw materials are benzene and xylene and can make >20,000 GWh/year of reactants

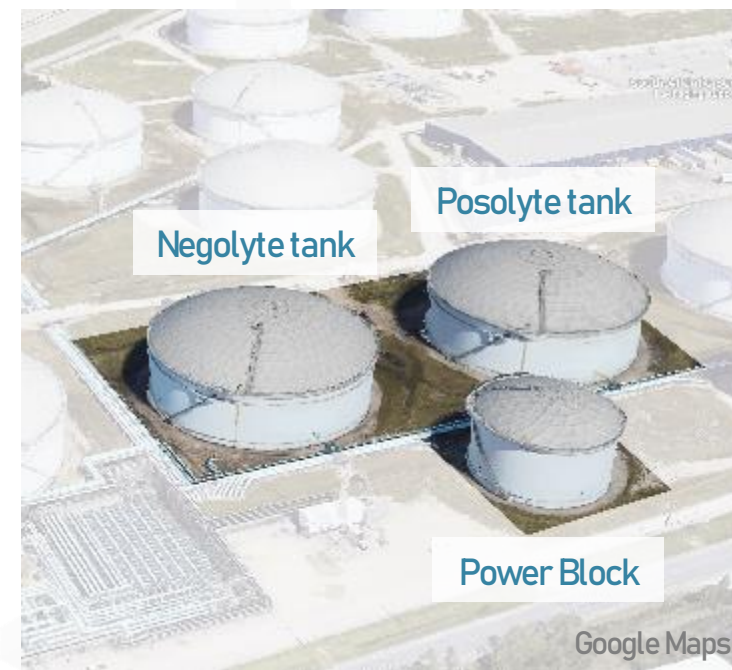


# Quino Energy Enables Ultrahigh Energy Density

Quino Energy's alkaline electrolyte is compatible with carbon steel tanks. Large tanks enable a very high areal energy density 3x that of LFP batteries.



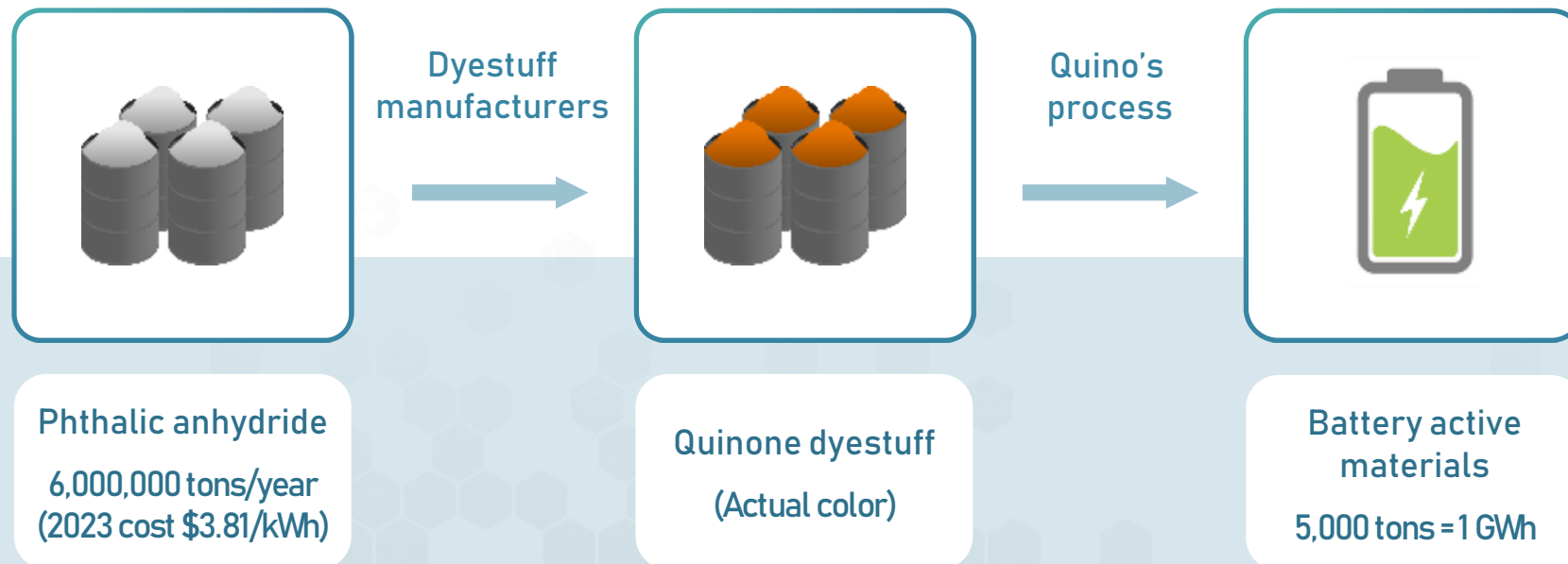
Elkhorn Battery in Moss Landing, CA  
(Tesla Megapack 2 XL)  
730 MWh, 13,500 m<sup>2</sup>, 54 kWh/m<sup>2</sup>



Enterprise Products Tank Farm in Houston, TX  
(Hypothetical Quino Energy LTFF RFB)  
150,000 m<sup>3</sup> at 20 Wh/L = 3 GWh, 18,000 m<sup>2</sup>, 167 kWh/m<sup>2</sup>

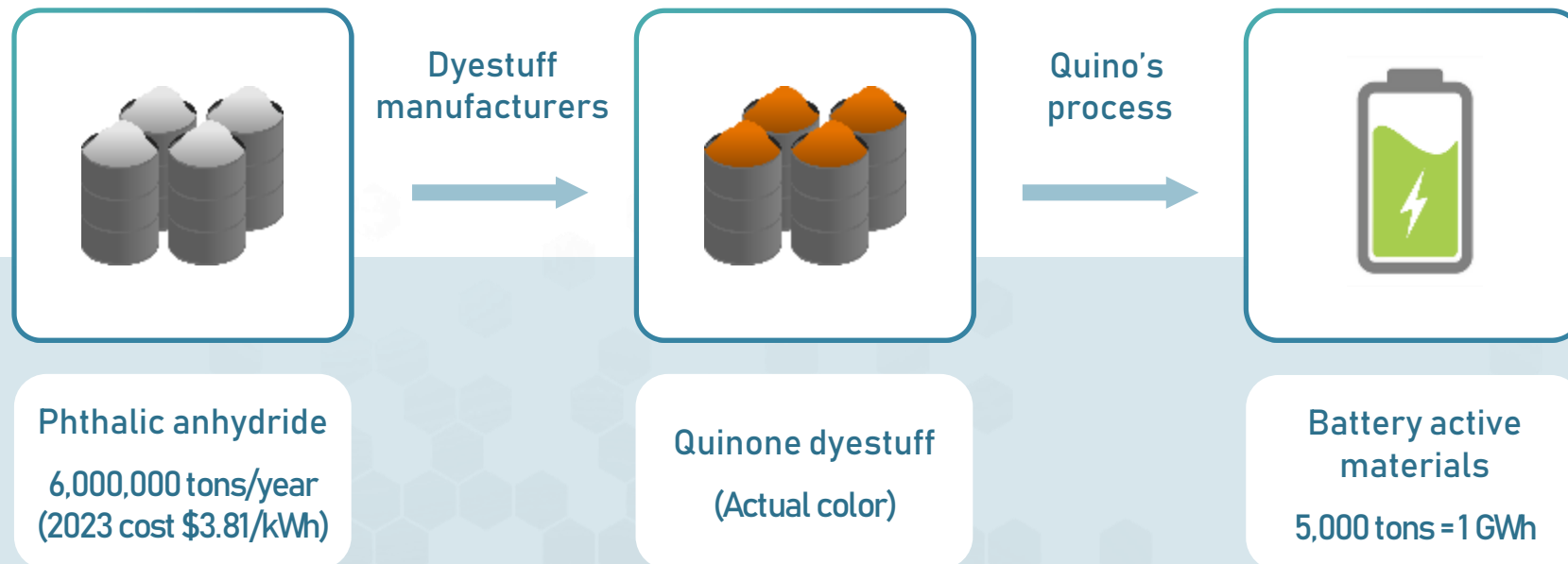
# Quino's Process Enables Easy Domestic Manufacturing and Massive Scalability

Quino Energy's battery materials are made from low-cost dyes...

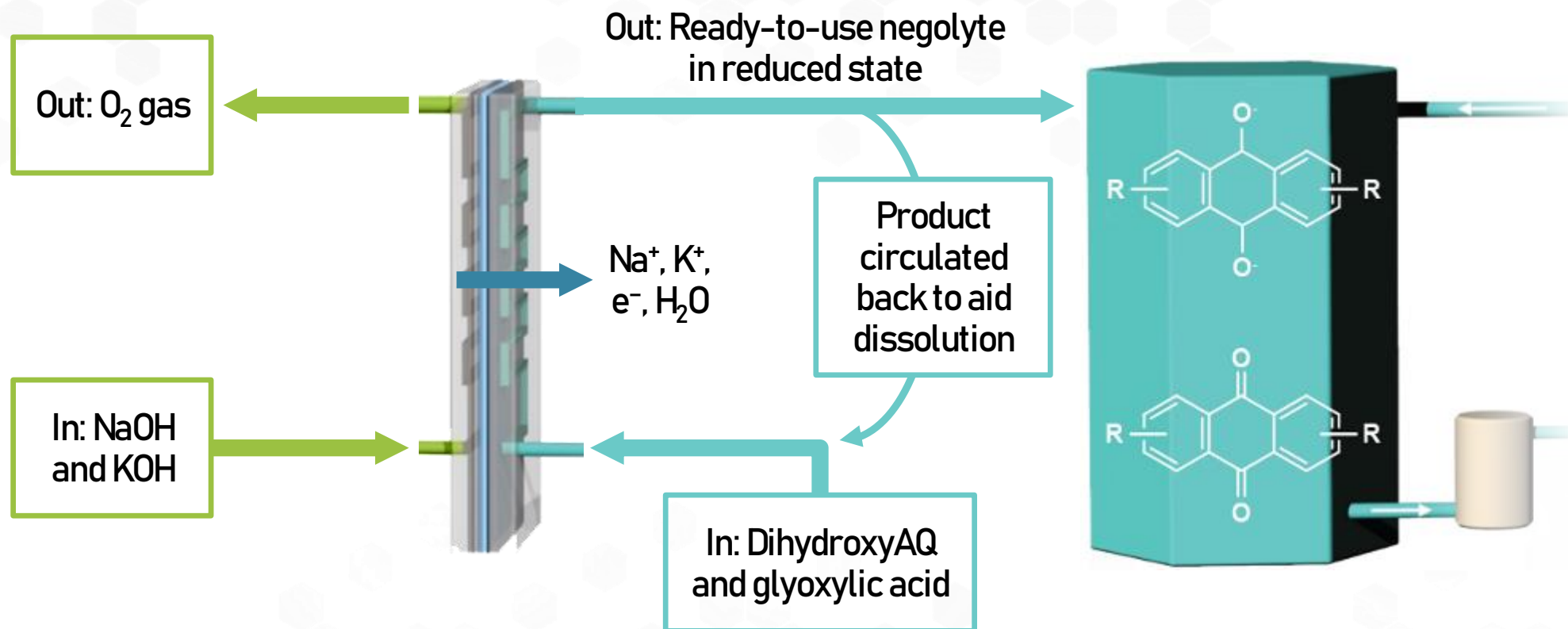


# Quino's Process Enables Easy Domestic Manufacturing and Massive Scalability

Quino Energy's battery materials are made from low-cost dyes in our one-step, zero-waste process that uses flow battery hardware as the production reactor itself.



# Quino's Process Enables Easy Domestic Manufacturing and Massive Scalability



Zero waste,  
continuous flow process

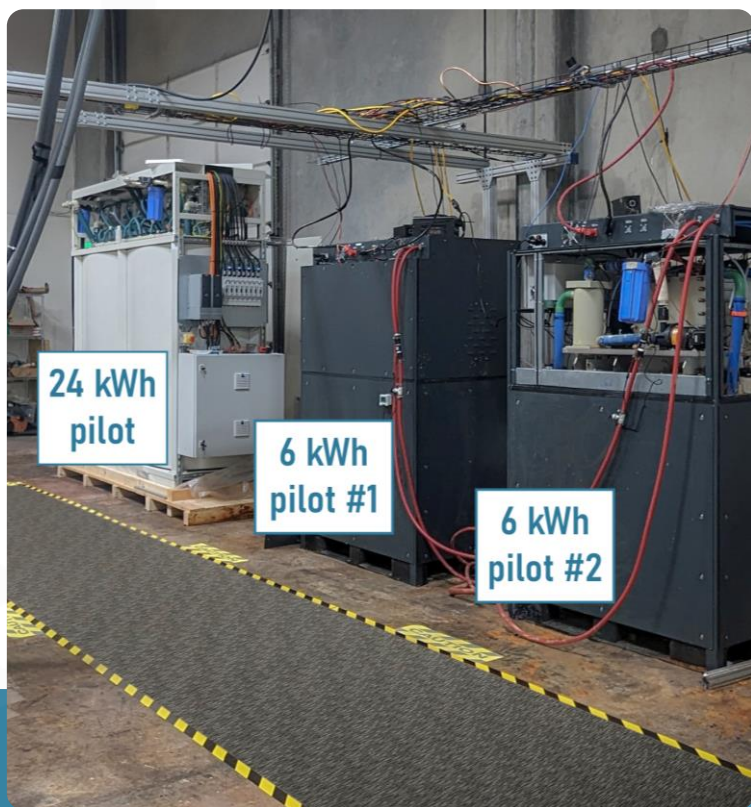
100% conversion,  
>95% purity



# Ton Scale Manufacturing of DCDHAQ: MRL 7

## Pilot Scale Cycling of DCDHAQ: TRL 6

Cycling in commercial flow battery systems





# Summing Up

## At Harvard (until April 2021)

- **MRL 3:** Gram-scale chemical synthesis at 70% yield
- **TRL 3:** 5 cm<sup>2</sup> single cells (~0.5 W, 0.5 Wh) in a glovebox
- ~10%/year capacity fade

## At Quino (April 2021 onwards)

- **MRL 7:** Pilot production line for zero-waste continuous flow e-chem synthesis at ton scale, 100% conversion, 95% purity
- **TRL 6:** Commercial flow battery systems (6 – 100 kWh) on a microgrid
- ~0.17%/year capacity fade



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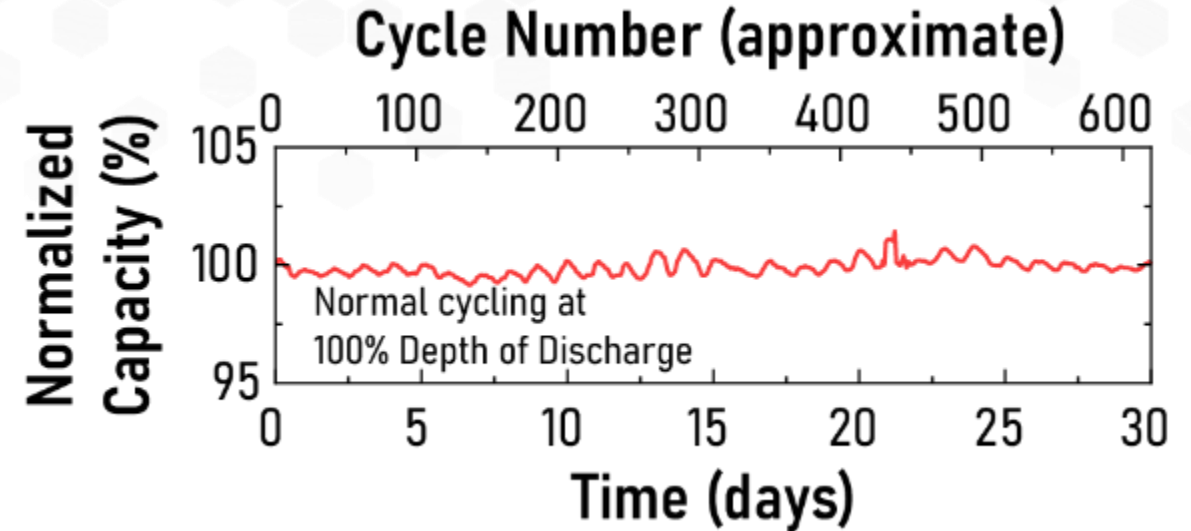
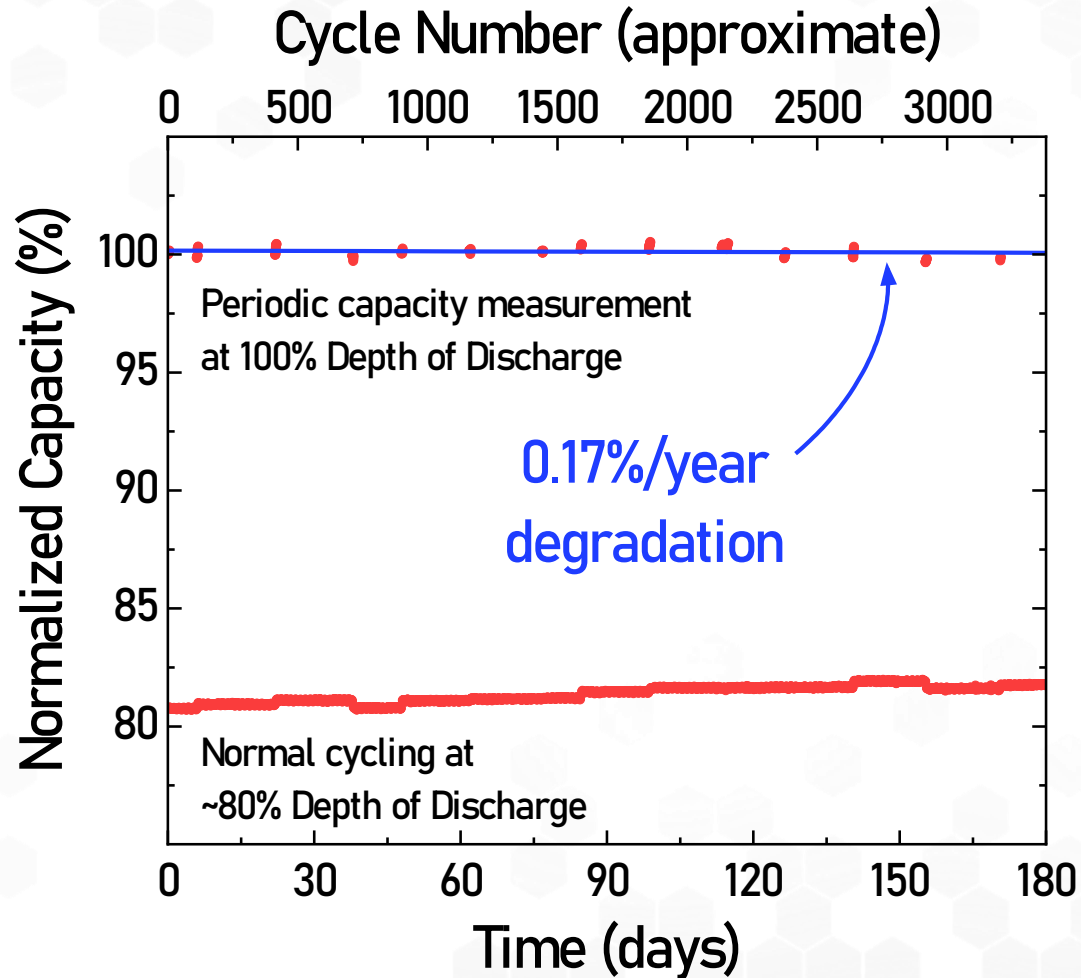


# For more information, get in touch

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# Long-Term Cycling of DCDHAQ vs. Ferrocyanide

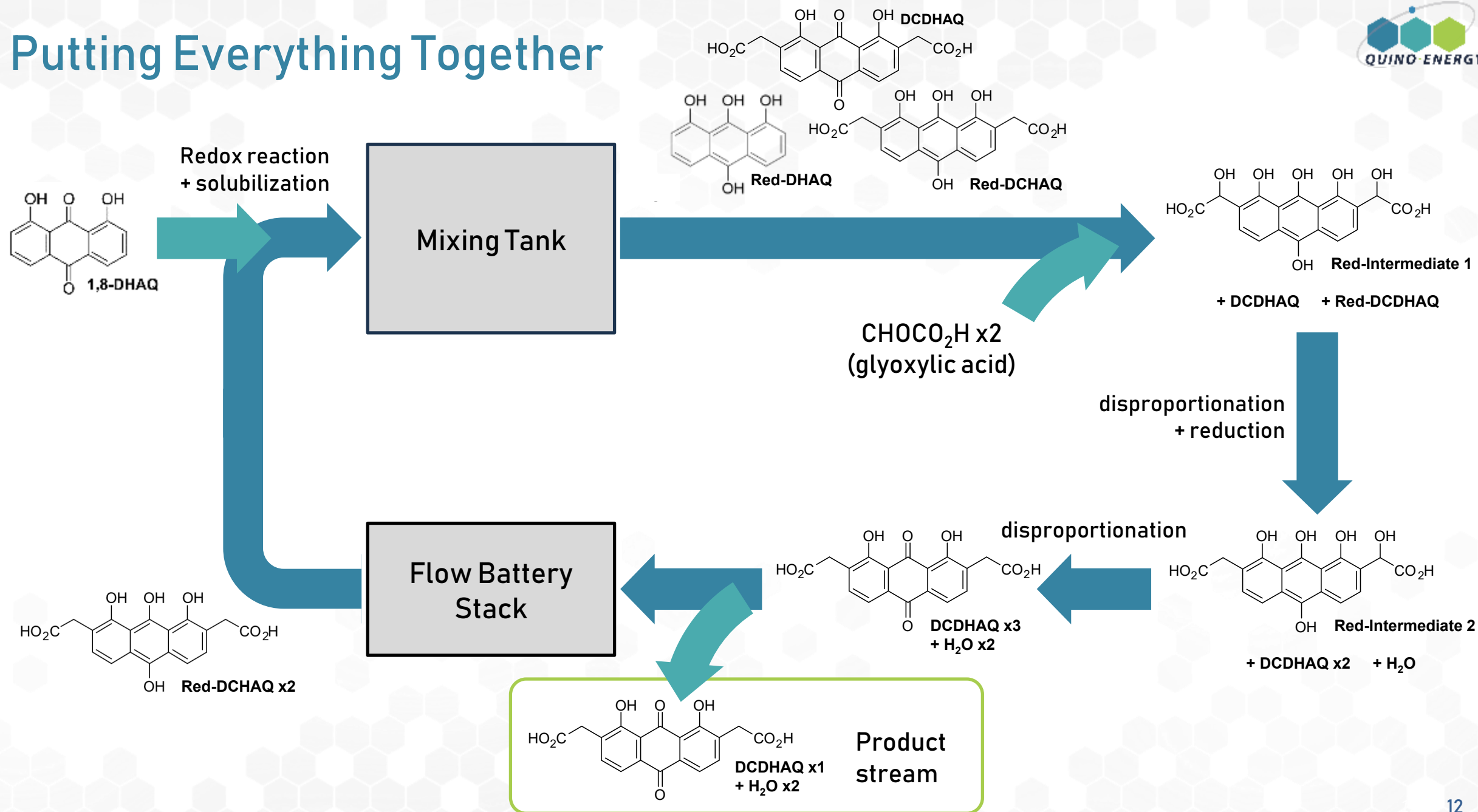


This experiment on the left gives  $\sim 0.17\%/year$  degradation over 6 months of cycling.

The exact degradation rate is so low that it is difficult to measure accurately!

At 1 cycle per day at 80% DoD, grid-scale LFP batteries degrade at 2.6%/year.

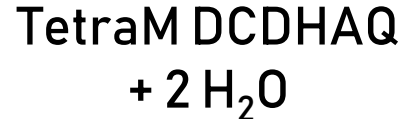
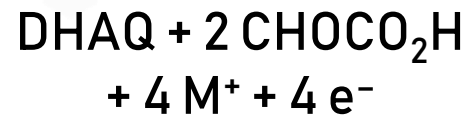
# Putting Everything Together



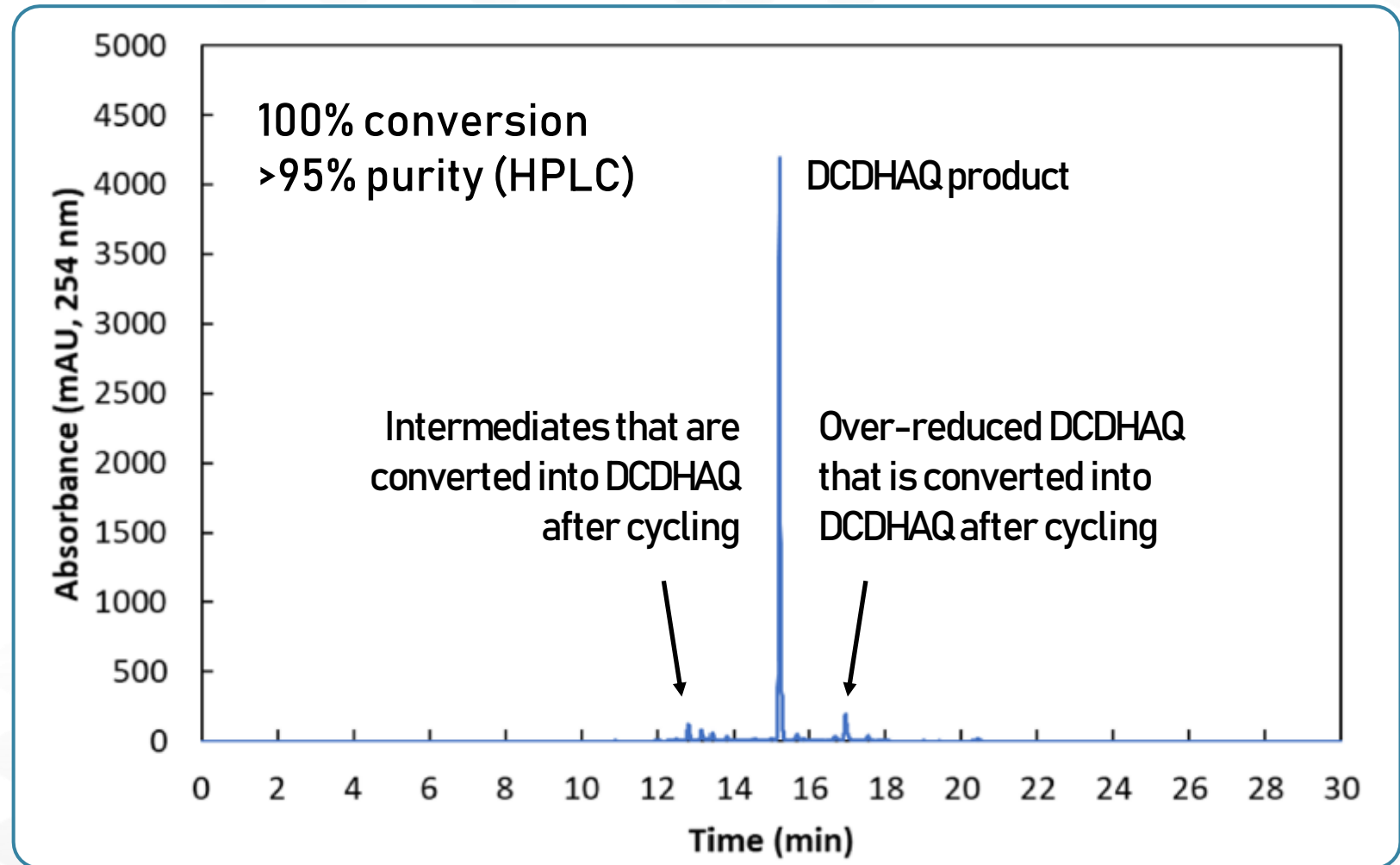
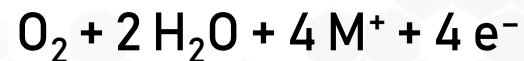


# Quino's Process Enables Easy Domestic Manufacturing and Massive Scalability

## Cathodic reaction



## Anodic reaction



# Rapid Growth Timeline Enabled by Leveraging Existing Vanadium RFB Hardware

