QUINO·ENERGY

Fully automated continuous flow electrosynthesis of high-performance organic FB active materials at multiton scale

Eugene Beh, Co-Founder and CEO
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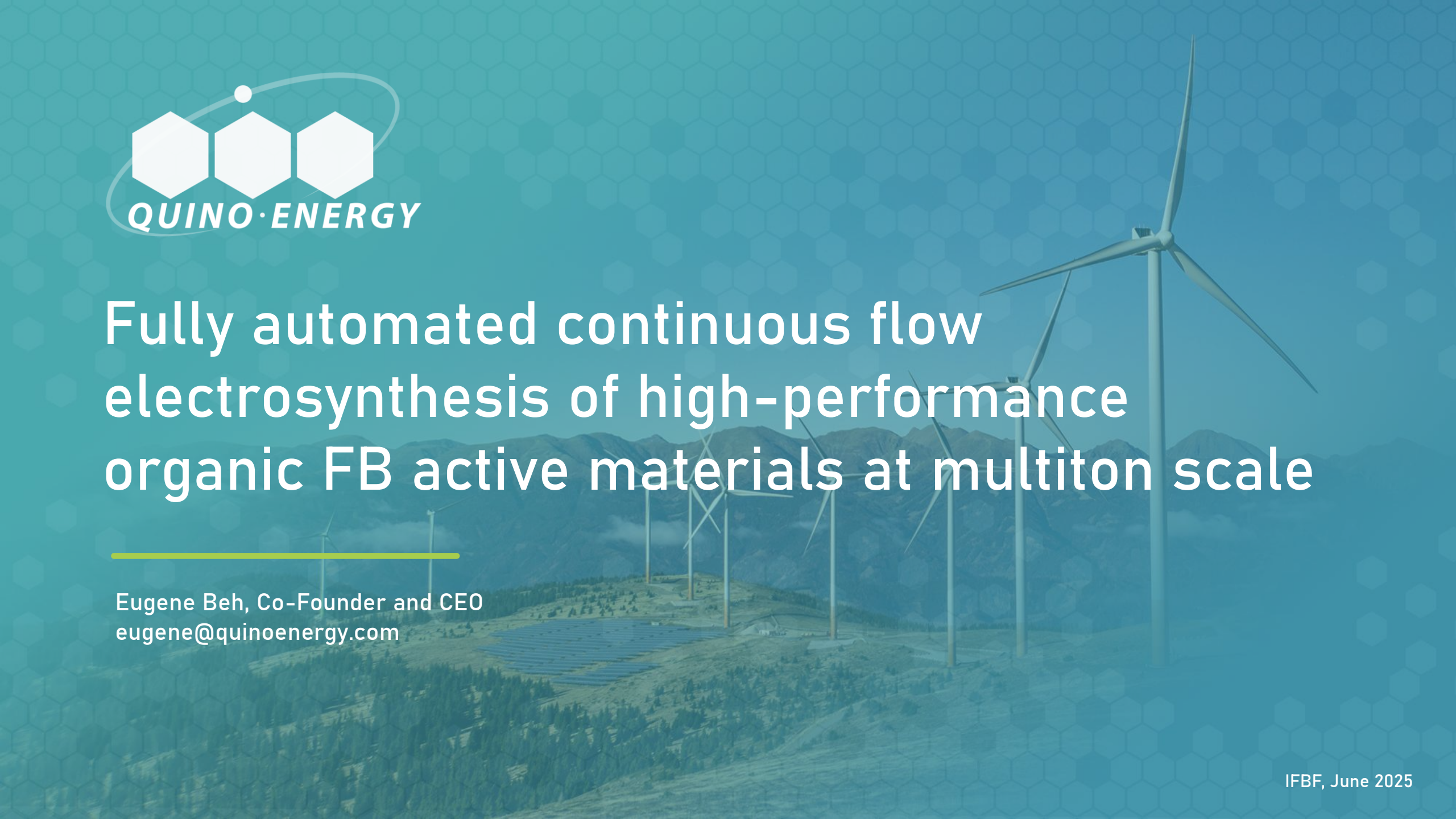
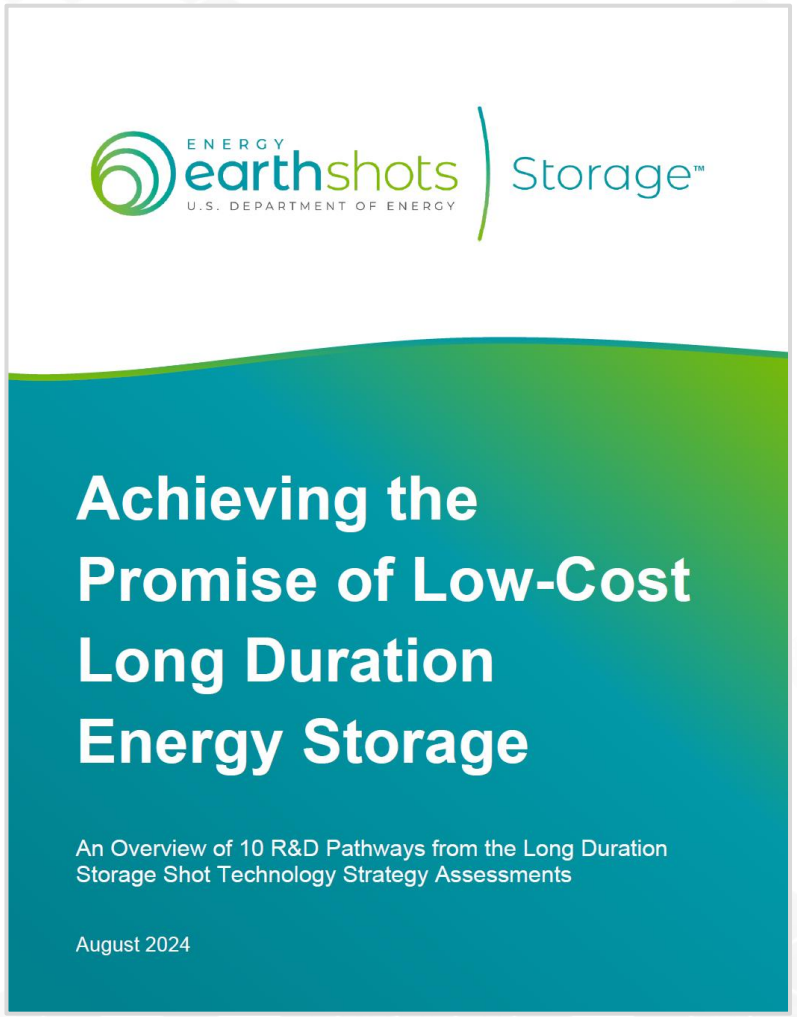
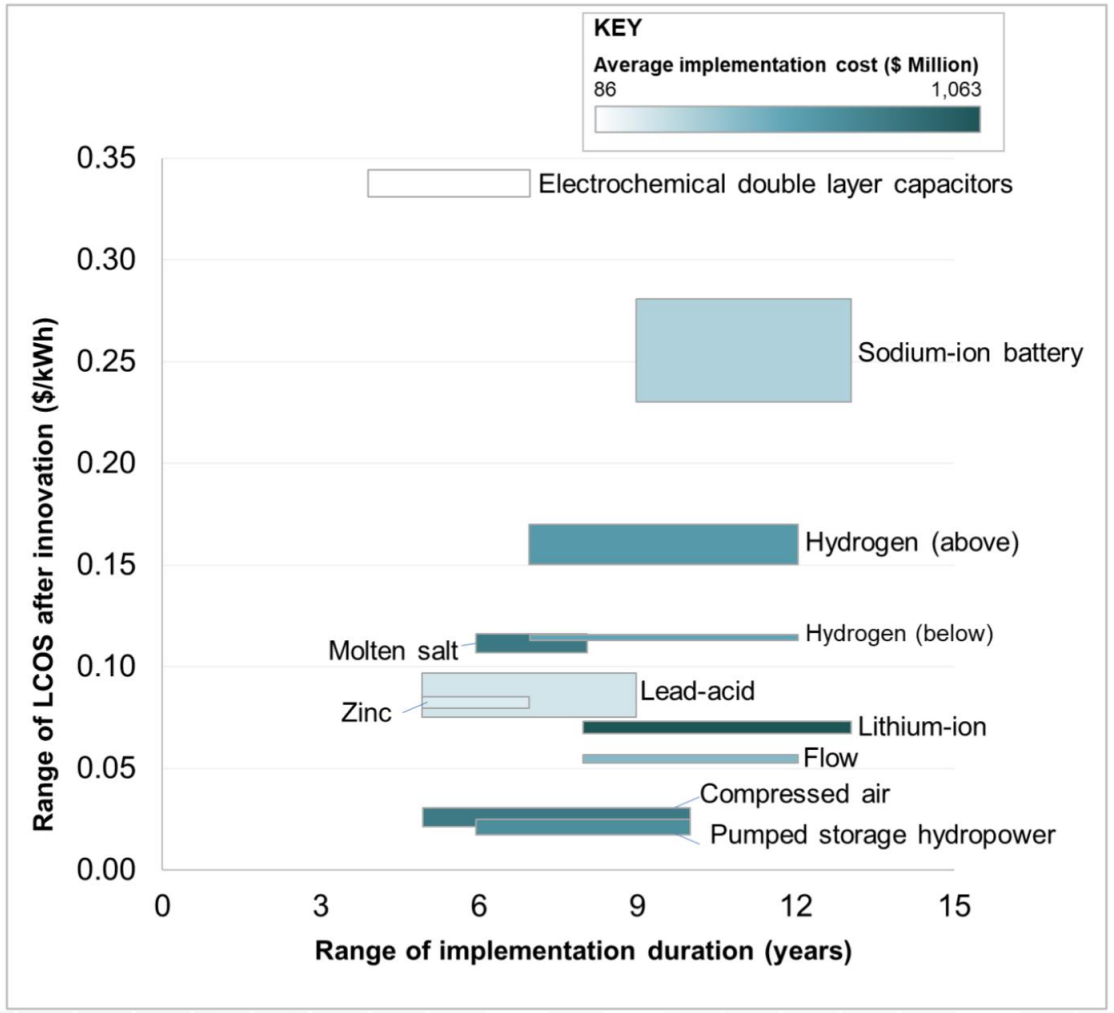


IFBF, June 2025

DOE August Report: Flow Batteries are the Only Non-Geologic LDES Tech to Beat Li-Ion on LCOS





DOE August Report: Flow Batteries are the Only Non-Geologic LDES Tech to Beat Li-Ion on LCOS

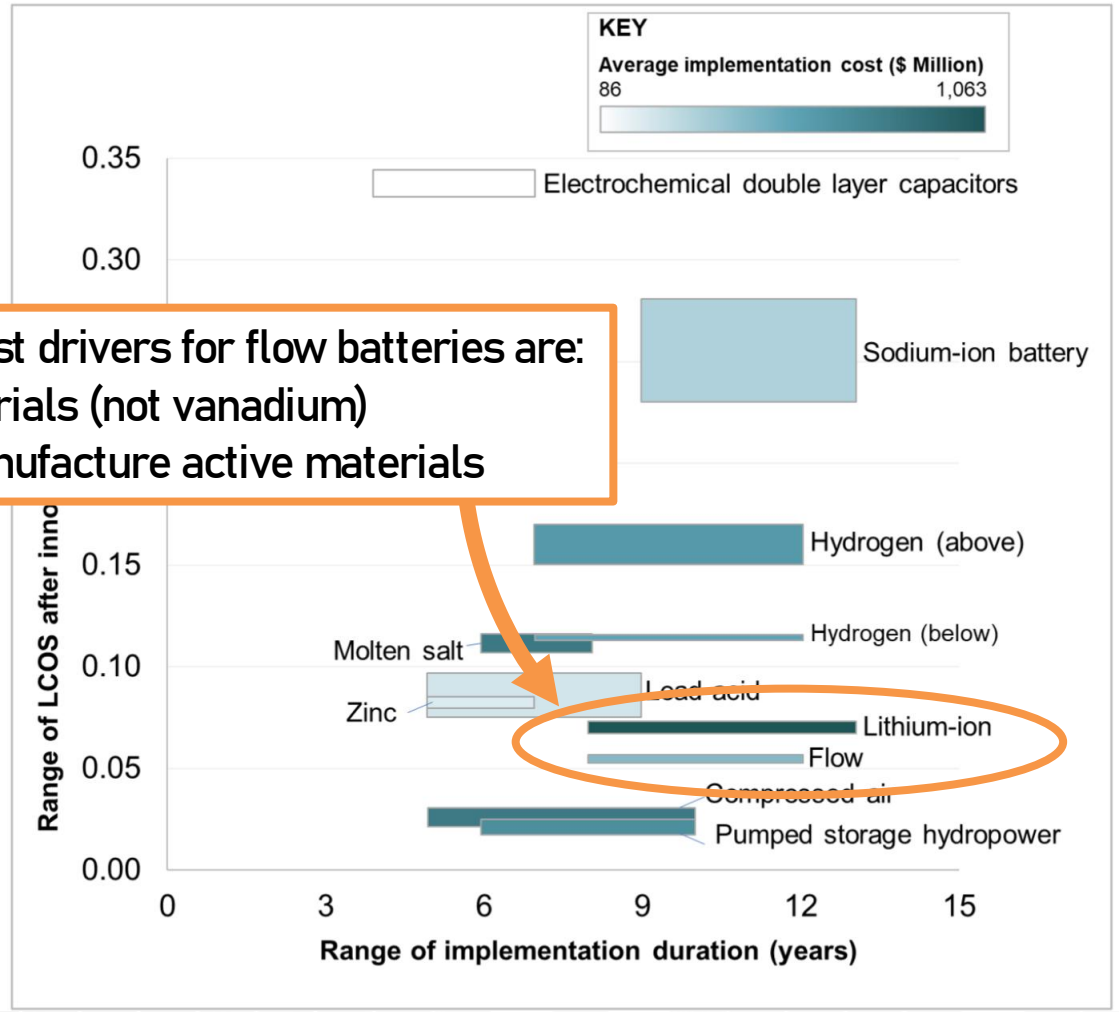
ENERGY earthshots U.S. DEPARTMENT OF ENERGY | Storage™

Achieving the Promise of Low-Cost Long Duration Energy Storage

An Overview of 10 R&D Pathways from the Long Duration Storage Shot Technology Strategy Assessments

August 2024

DOE's two biggest cost drivers for flow batteries are:
1. New active materials (not vanadium)
2. Processes to manufacture active materials

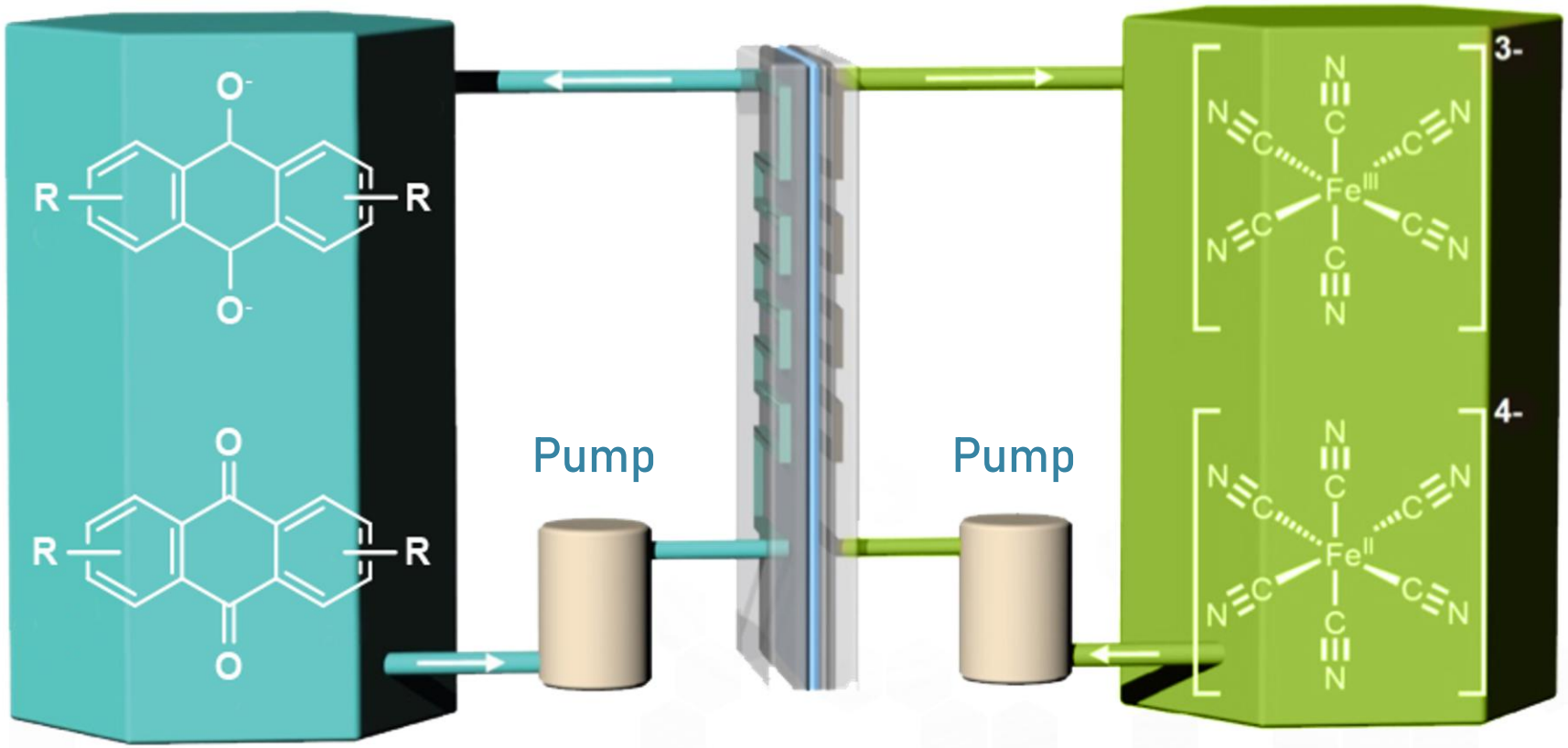


Quino Energy is a Harvard Spinoff Commercializing Organic Flow Batteries

Quinone
from xylene

Flow battery stack

Ferrocyanide
(non-toxic food additive)



Prof. Michael Aziz

Prof. Roy Gordon

Fundamental technology licensed from Harvard

Quino Energy is a Harvard Spinoff Commercializing Organic Flow Batteries

HARVARD UNIVERSITY

U.S. DEPARTMENT OF ENERGY

2013
Harvard invents Organic Flow Battery

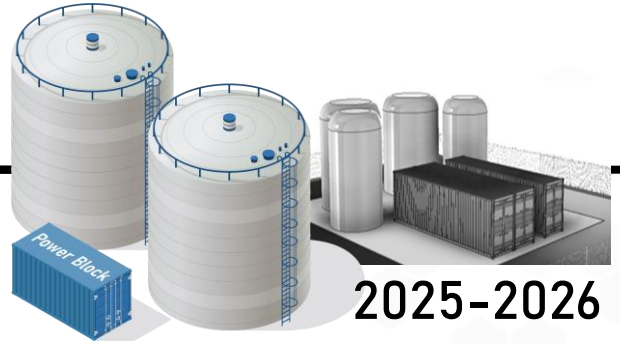
2019
Harvard solves Organic Flow Battery lifetime

2021
Quino Energy founded, tech license signed

2022
~$10M DOE + Seed Funding

2023
Chemical Pilot line: MRL 7

2024
100 kWh lab pilot system: TRL 6



2025-2026
Multi-MWh-scale TRL 7 pilots

Key Features of Organic Flow Batteries

Extremely Low-Cost Electrolytes and Components

- Enables flow batteries to compete with LFP on cost
- No critical materials or PFAS

Mega-Scalable

- TWh/year of raw material supplies available
- Backward compatible with VFB hardware

No Hydrogen

- Fire safe
- Simple operation with no major reengineering

Compatibility with Steel Tanks (in some cases)

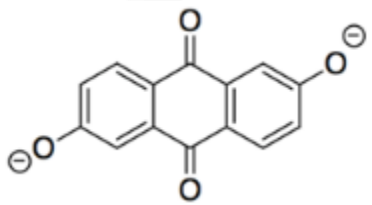
Unlock additional cost and time savings on installation

What's the Challenge?

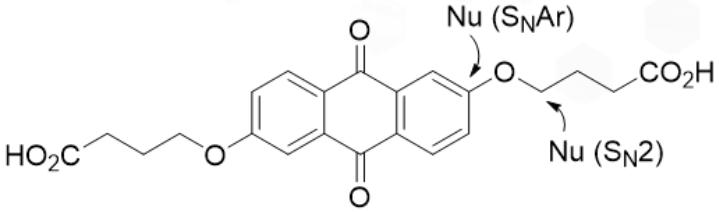
Finding organic active materials that don't degrade is **really hard**.

Design Principles for Low-Degradation Quinone Negolytes

2,6-DHAQ:
Fade rate ~4-5%/day



DBEAQ:
Fade rate 0.04%/day (~14%/year)

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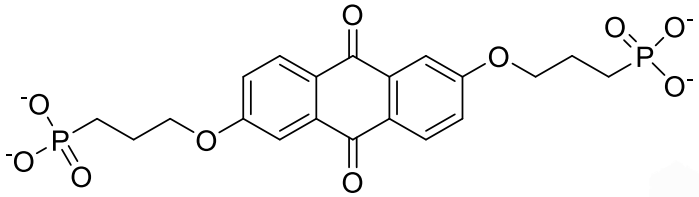
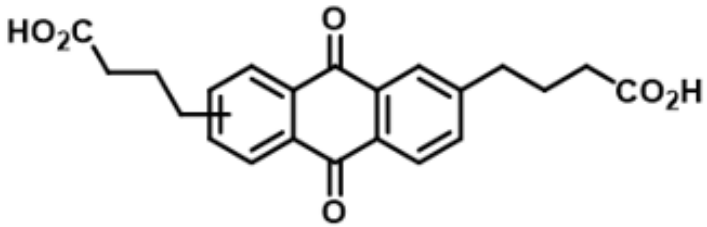
DPPEAQ: Fade rate 0.014%/day (~5%/yr)

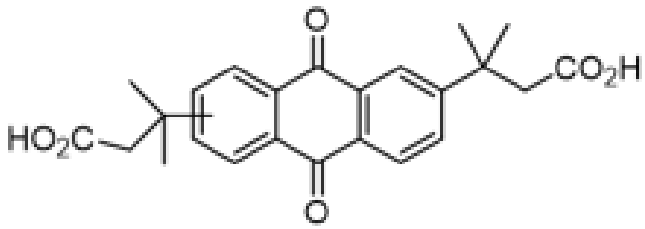


- Higher stability vs. DBEAQ from lower pH operation (pH 9)
- Phosphonate is a weaker nucleophile than carboxylate

DBAQ: 0.0084%/day (3%/yr)



DPivOHAQ: 0.00018%/day-0.014%/day (<1-5%/yr)



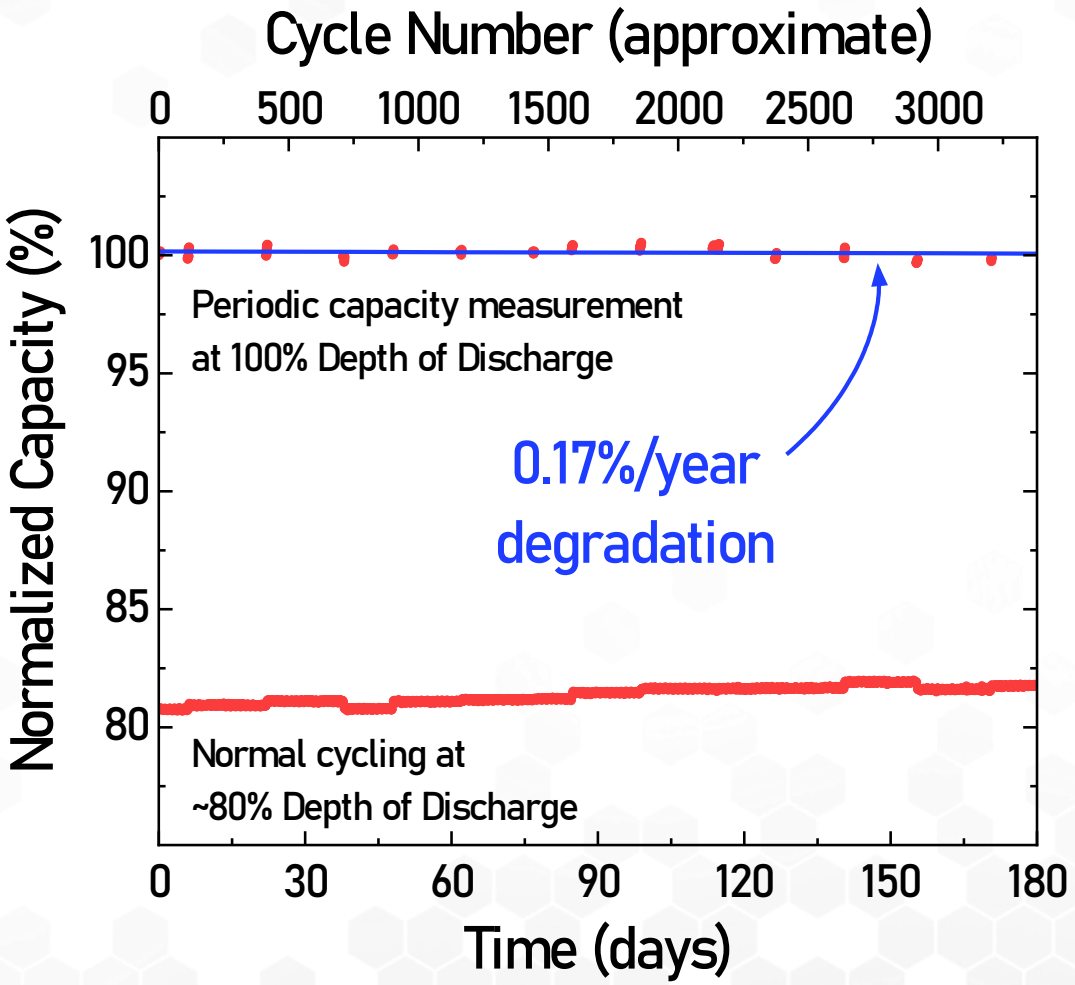
Higher stability vs. DBEAQ
by eliminating ether linkage

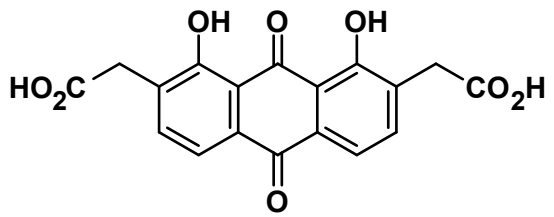
Design Principles for Low-Degradation Quinone Negolytes

- ✓ More linkers to core = higher stability
- ✓ More solubilizing groups = higher energy density

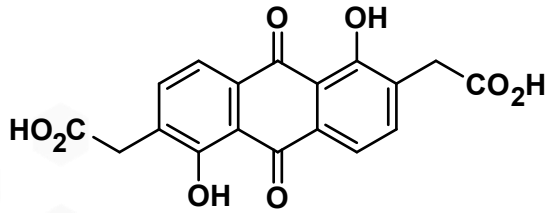
Intrinsically Low-Degradation Quinone Negolytes

DCDHAQ: Fade rate ~0.17%/year (single cell) or ~1.5%/year (commercial system)





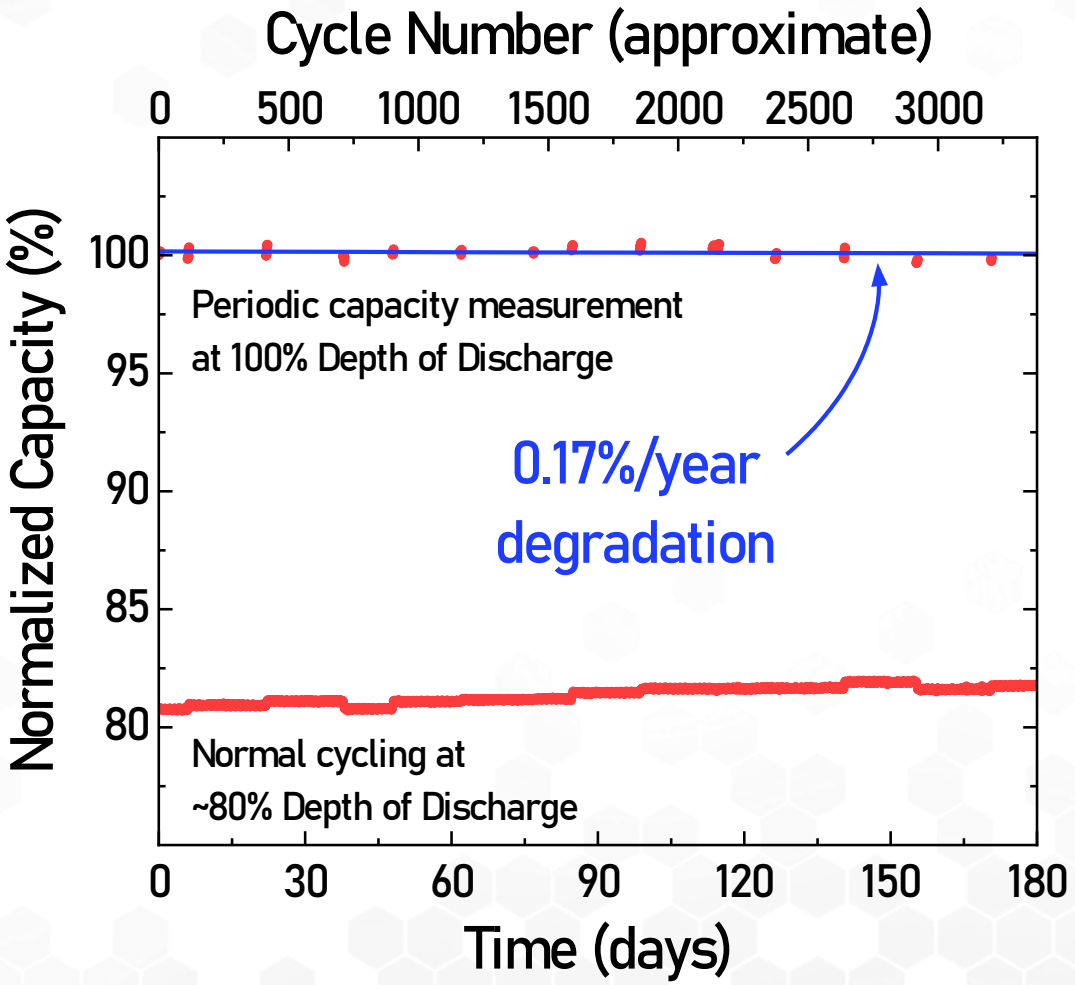
1,8-DCDHAQ

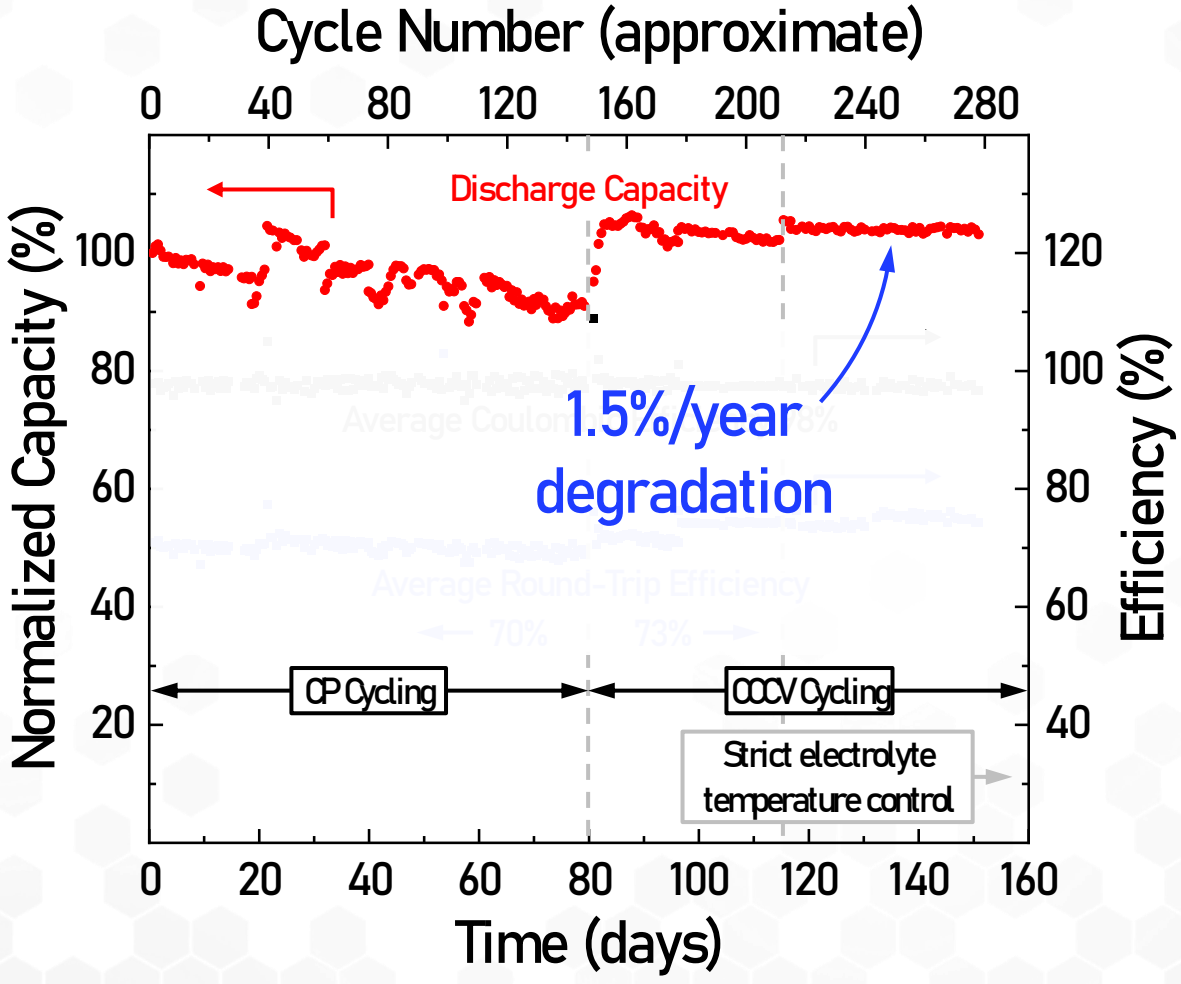


1,5-DCDHAQ

Intrinsically Low-Degradation Quinone Negolytes

DCDHAQ: Fade rate ~0.17%/year (single cell) or ~1.5%/year (commercial system)





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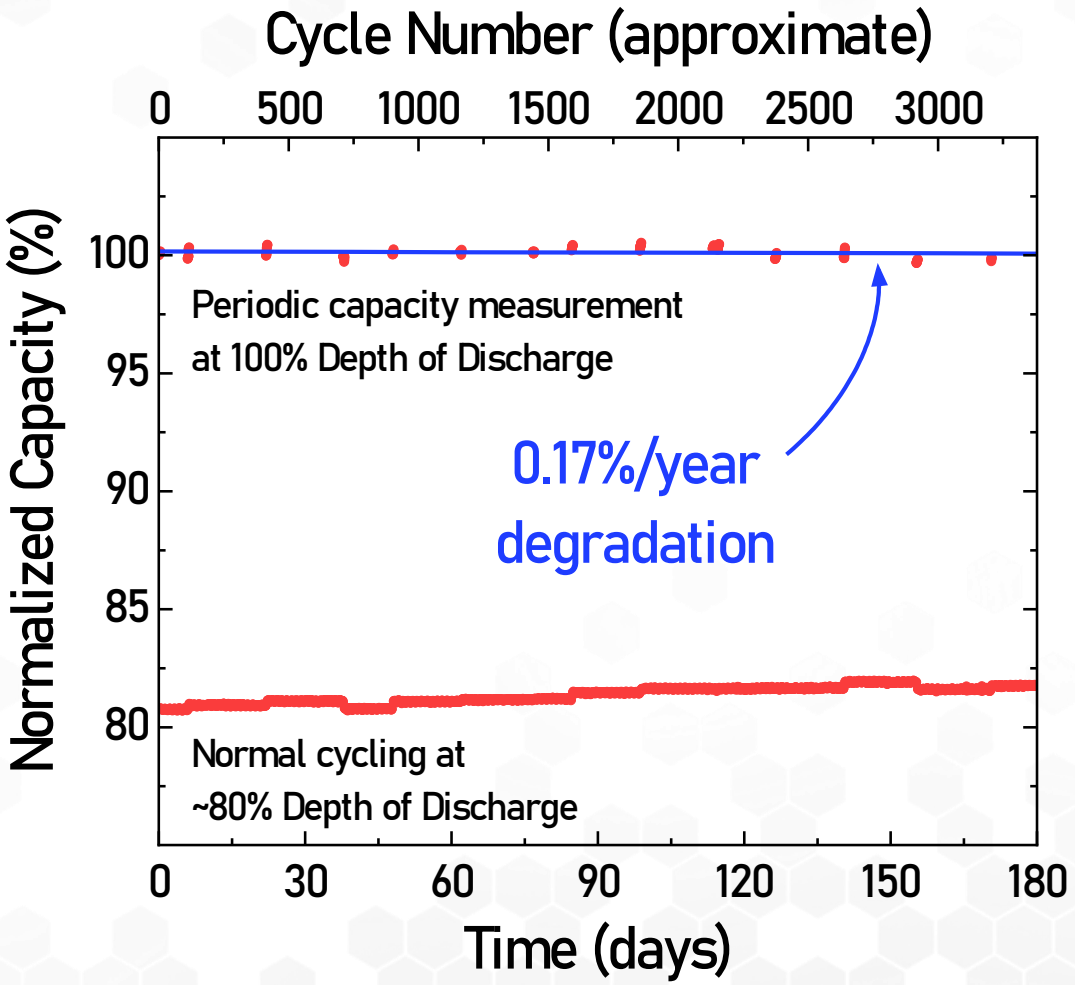
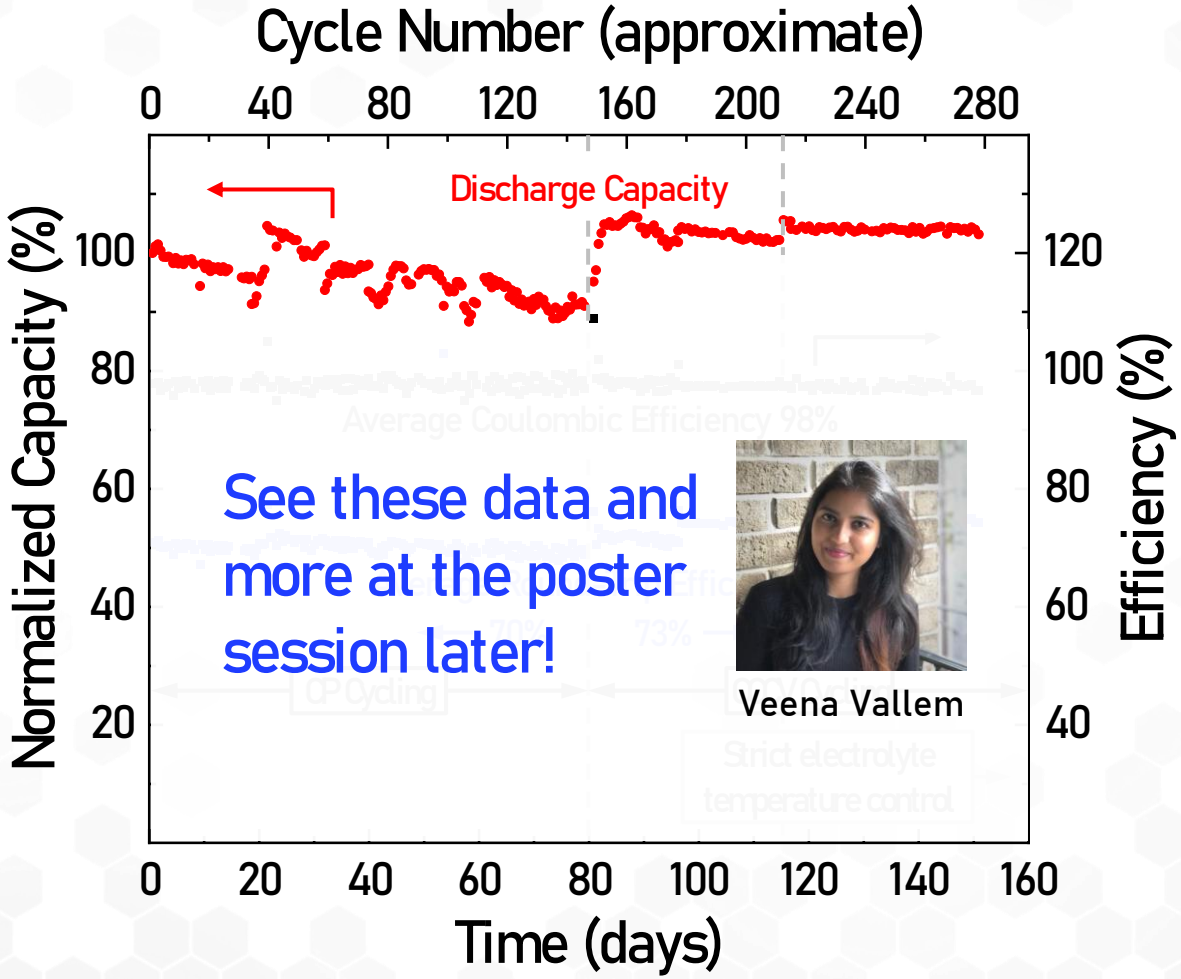


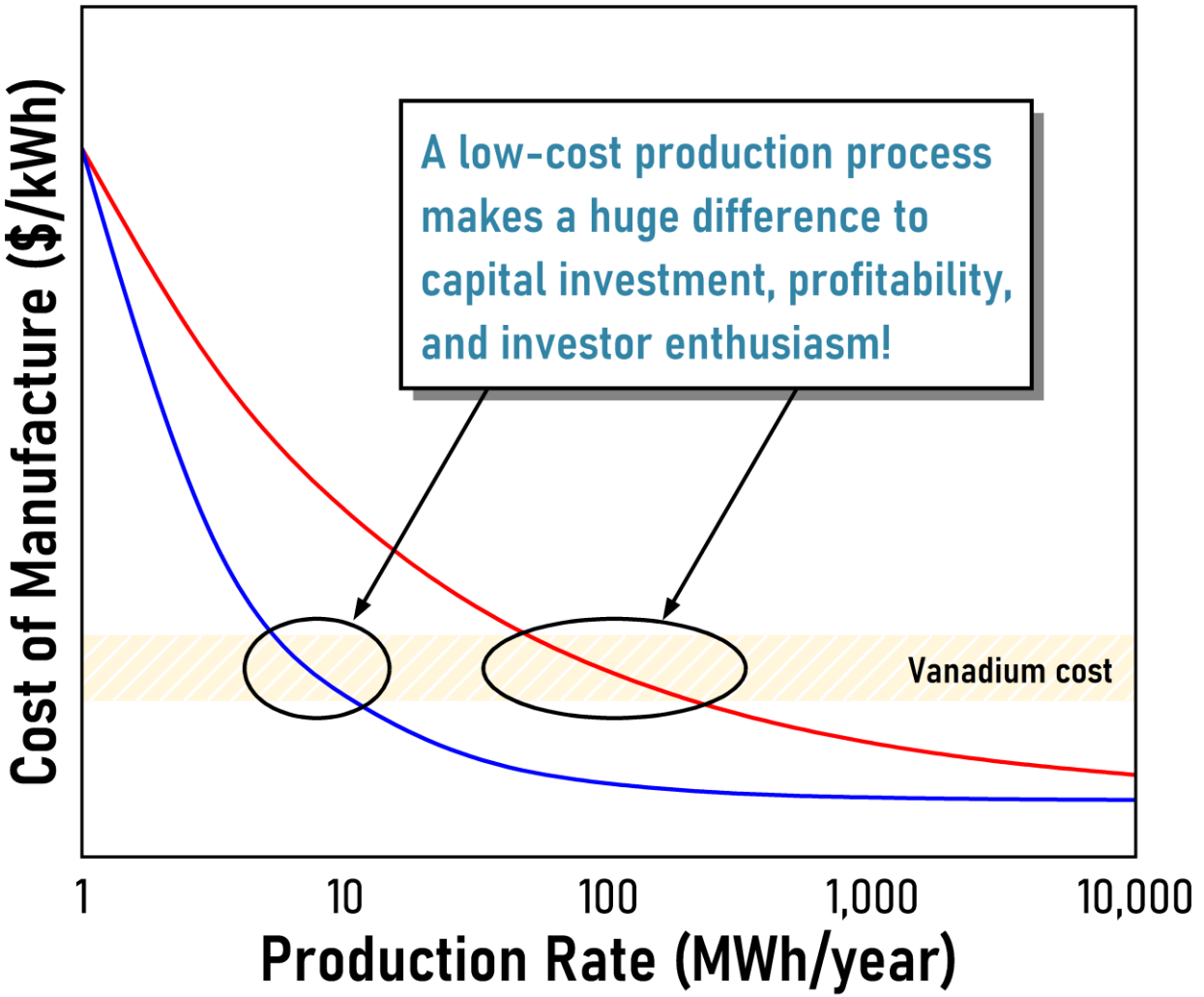


Scalability is Key for Organic FB Electrolytes

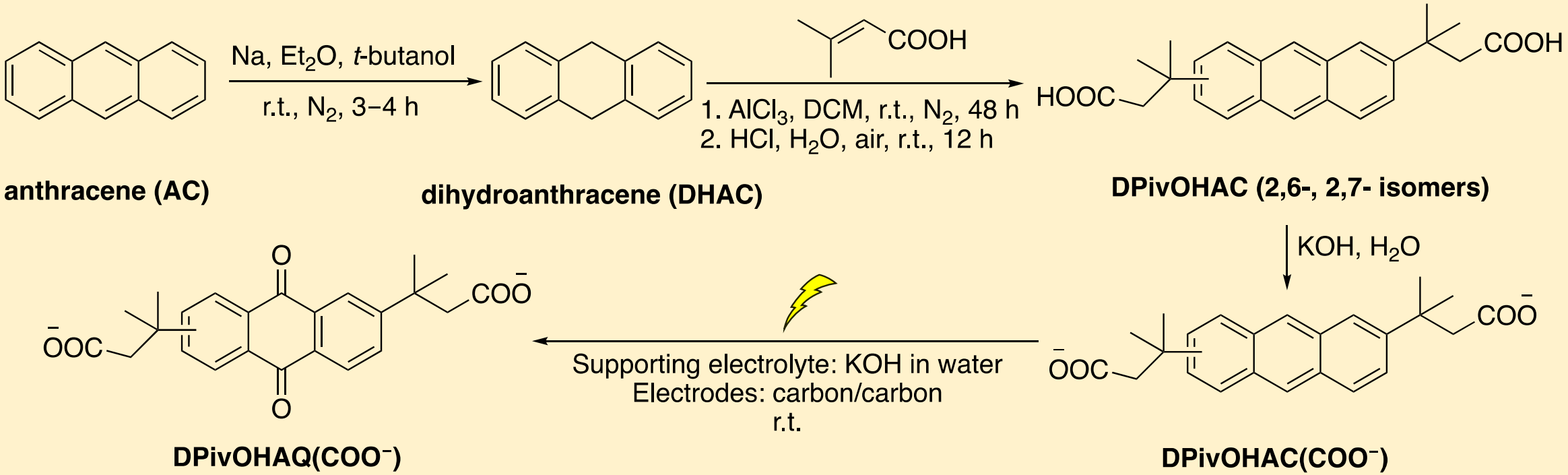
Finding organic active materials
that don't degrade is really hard.

Making them cheaply and scalably,
even at modest scales, is even harder.

Scalability is Key for Organic FB Electrolytes



DPivOHAQ: Great Lifetime, Expensive Synthesis, Unsuitable for Commercialization



Y. Jing, M. J. Aziz et al., *Green Chem* 2020, *22*, 6084–6092

Electrosynthesis of DCDHAQ Meets All Relevant Process Considerations

- ✓ $/kWh, not $/kg
- ✓ Start from low cost raw materials
- ✓ Atom economy
- ✓ Avoid organic solvents
- ✓ Minimal workup/purification
- ✓ Minimize waste
- ✓ Absolutely no Pd/Pt catalysts

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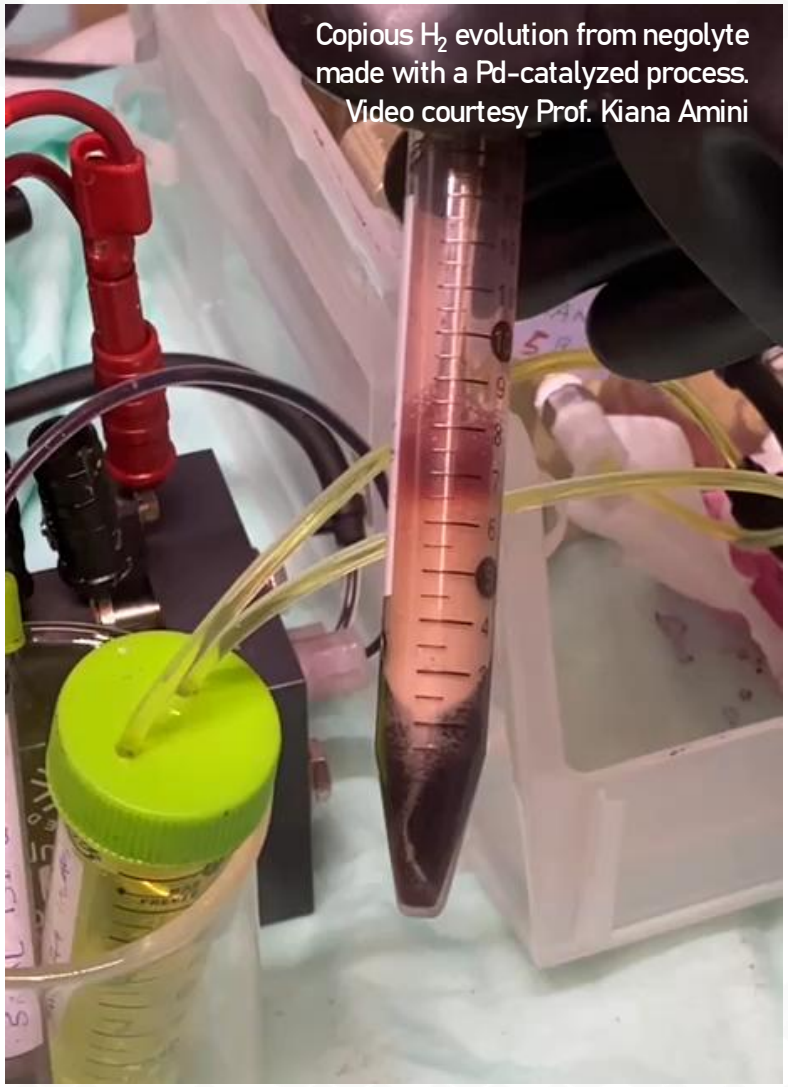
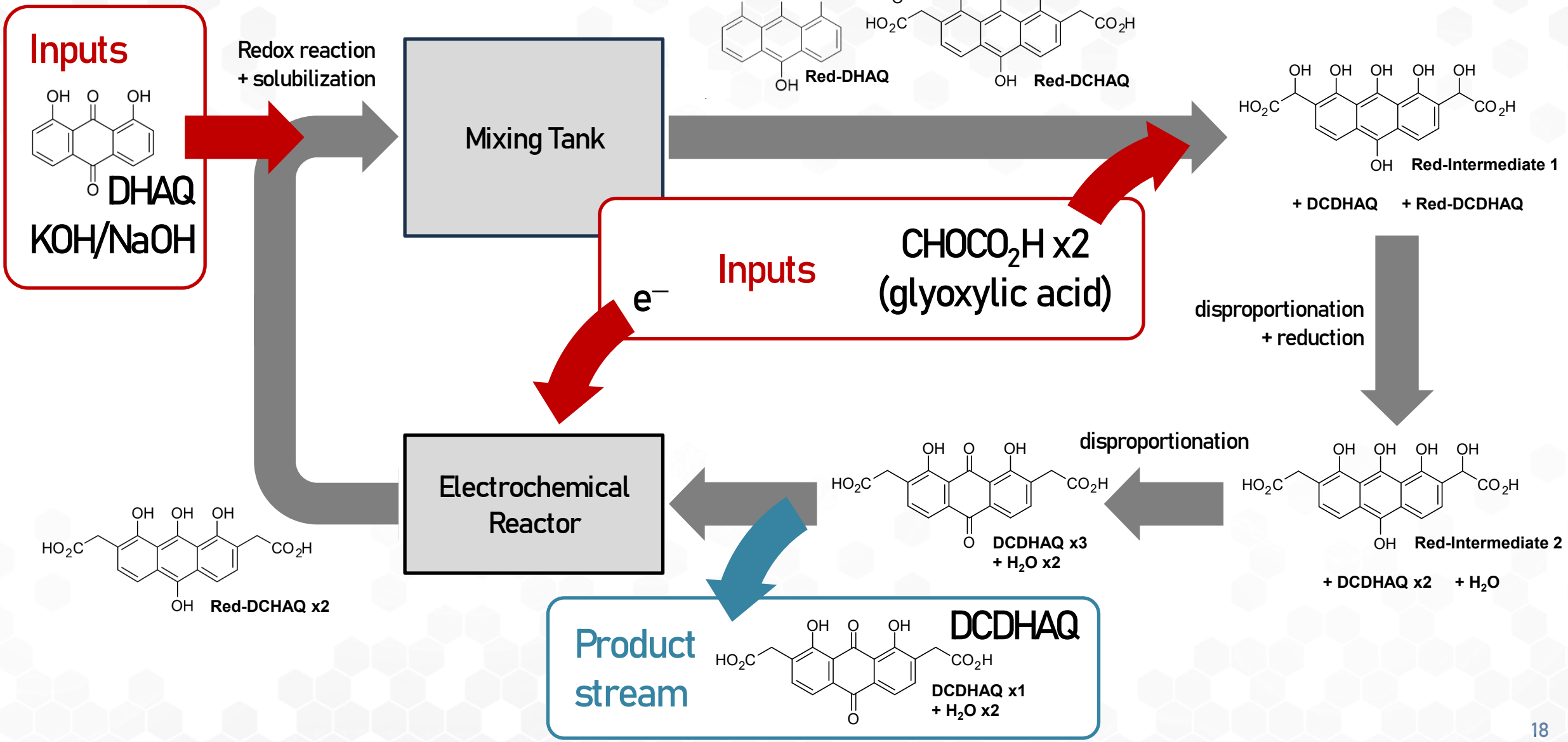


Copious H_2 evolution from negolyte made with a Pd-catalyzed process. Video courtesy Prof. Kiana Amini

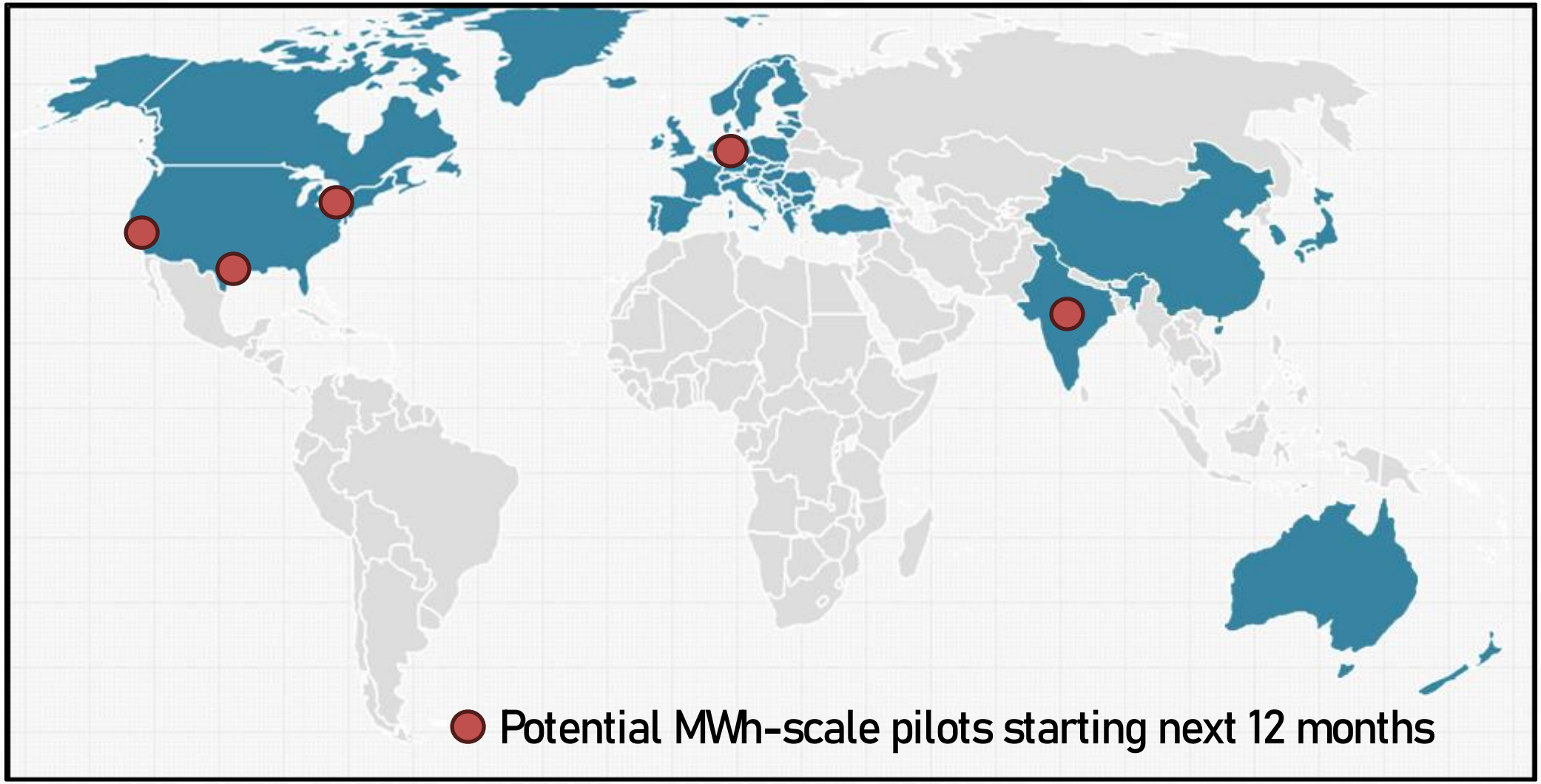
Continuous-Flow Production of DCDHAQ



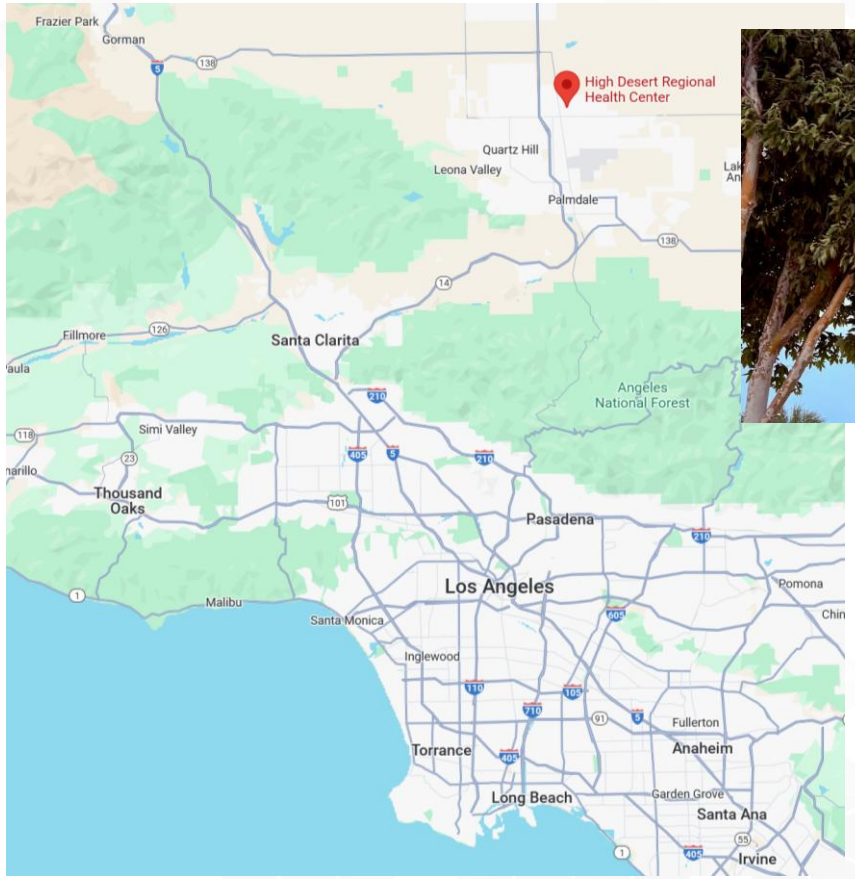
MRL 7: Multi-ton Scale Production of DCDHAQ on a Fully-Automated Pilot Production Line

Active material pilot production line
Produces 150 tons/year, or 25 MWh/year

Quino Energy and Partners are Piloting OFBs



Example Project: 500 kW / 8 MWh Pilot Deployment + 300 kW Onsite Solar in Los Angeles County Microgrid



Generously funded by:

STATE OF CALIFORNIA ENERGY COMMISSION

+

Undisclosed Funding Agency

Starting Q4 2025, online by end of 2027

Closing Thoughts

1. The zero-waste electrochemical production of DCDHAQ enables the first commercially viable organic RFB, with a projected energy CAPEX 1/4 that of vanadium ($40-45/kWh).

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Closing Thoughts

1. The zero-waste electrochemical production of DCDHAQ enables the first commercially viable organic RFB, with a projected energy CAPEX 1/4 that of vanadium ($40-45/kWh).

2. It is not enough to project low costs at some large future scale. Commercial success requires a simple manufacturing process that can achieve low costs even at modest scales.

3. Being backwards compatible with vanadium flow battery systems enables rapid scaling by shifting the challenge from R&D/engineering to primarily supply chain management.

Work With Us!

Utilities and Developers: MW-scale pilot projects COD 2027+

EPCs: Constructing MW-scale pilot projects. Investing in engineering design for utility-scale large tank form factor systems.

RFB Manufacturers: Joint optimization of your FB stacks and systems for our organic electrolyte. Supply of such systems to pilot projects.

Chemical Manufacturers: Manufacturing scaleup and delivery of electrolyte in regions with confirmed projects. Sourcing and supply chain management.

QUINO·ENERGY

Thank You!

Eugene Beh, Founder and CEO
eugene@quinoenergy.com

U.S. DEPARTMENT OF ENERGY

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