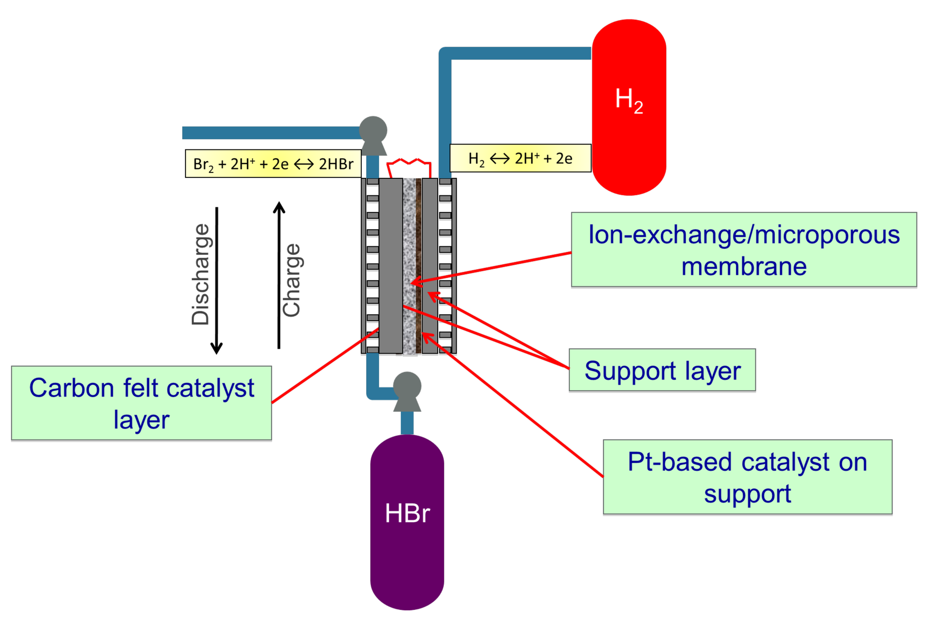
H_2/Br_2 Flow Battery for Grid-Scale Energy Storage

Venkat Srinivasan, Adam Weber, & Vince Battaglia
Lawrence Berkeley National Laboratory • DOE ESS Review • Washington, DC • September 26, 2012
vsbattaglia@lbl.gov

Purpose

Develop a low-cost, energy-storage system with high power density at 80% efficiency

Use H_2 and Br_2 in a flow battery



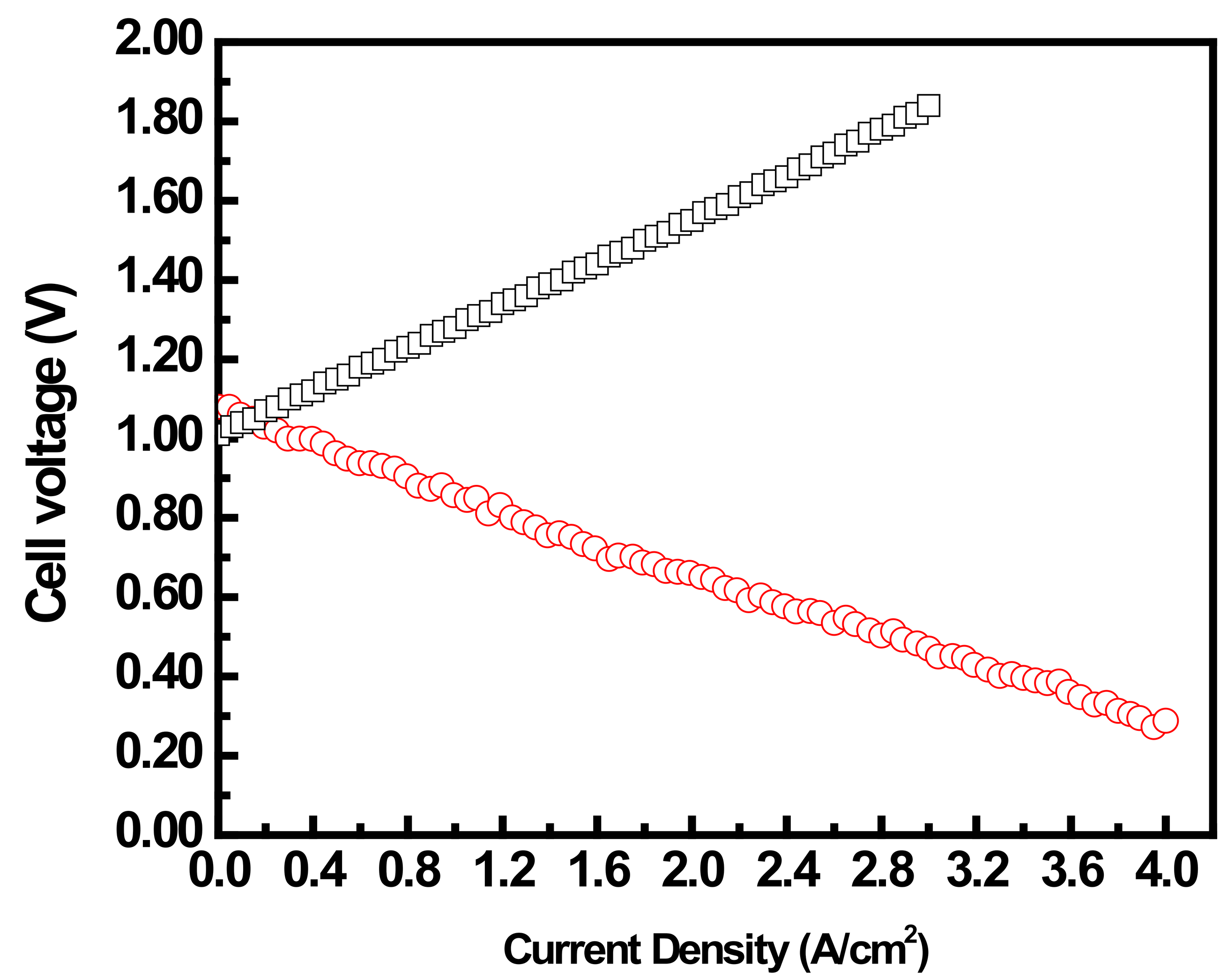
No noticeable side reactions up to 1.8 V

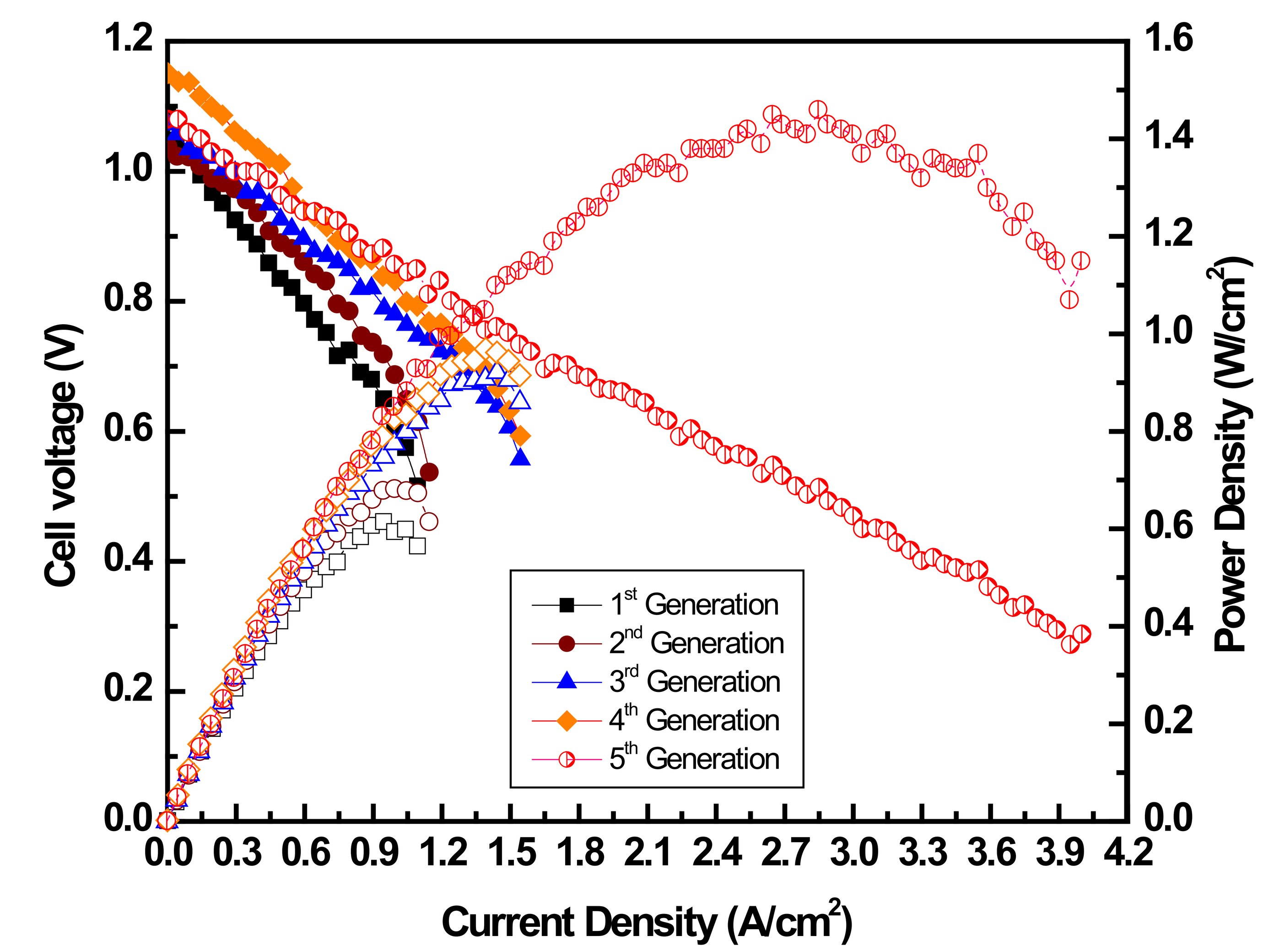
No mass transfer limit at 4 A/cm²

Progress

(past year)

Improve cell performance of system with low-cost chemicals with excellent kinetics





Future Plans

Scale-up; cycleability and durability

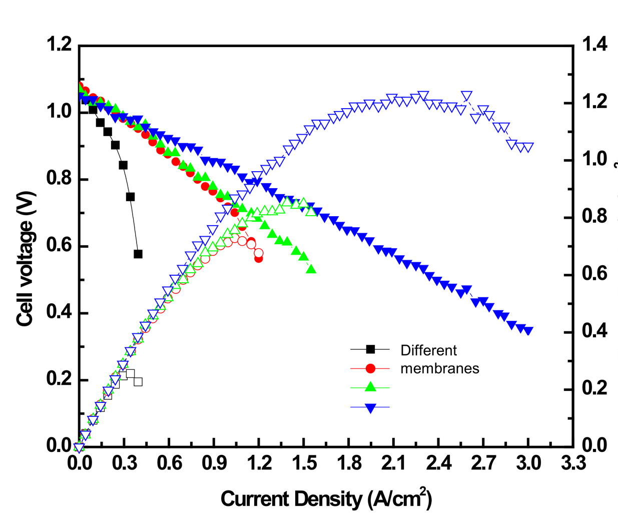
Project 16 k+ cycles w/< 20% power loss

High peak power (1.4 W/cm²)

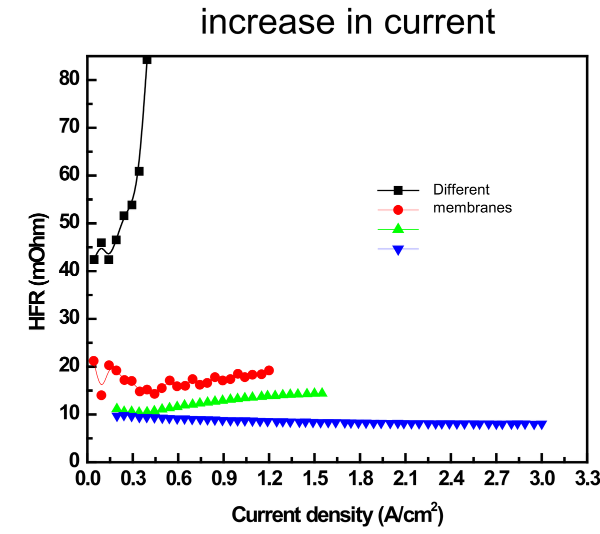
High power at high efficiency

Voltaic efficiency	PD (W/cm²)
80 %	0.99
90 %	0.60

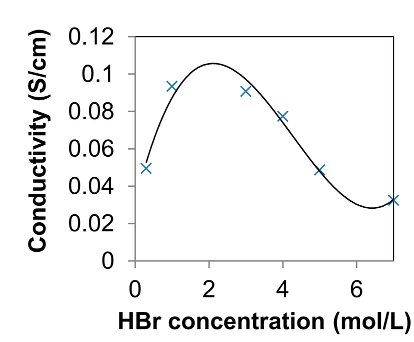
Thinner membranes reduce ohmic losses



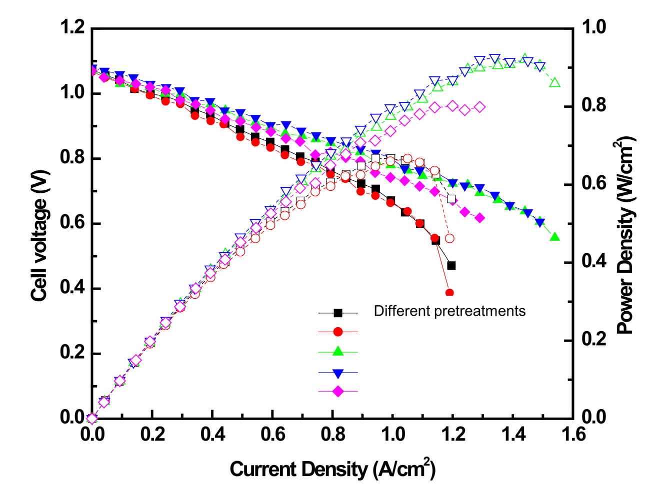
Some membranes show reduction in impedance with increase in current

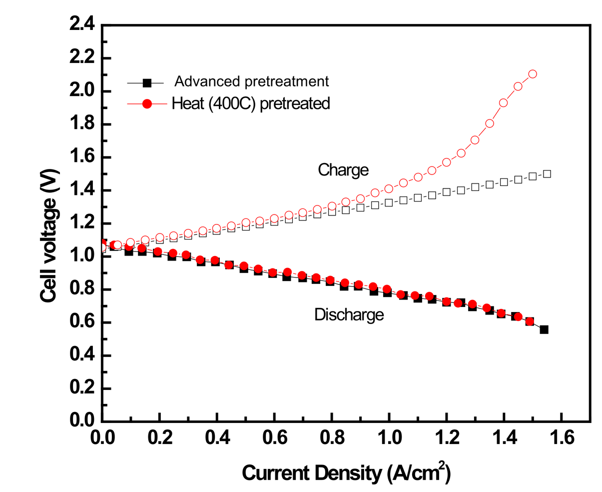


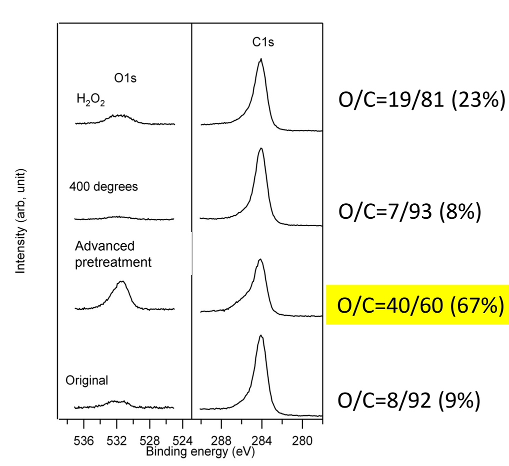
Membrane conductivity is a function of HBr concentration



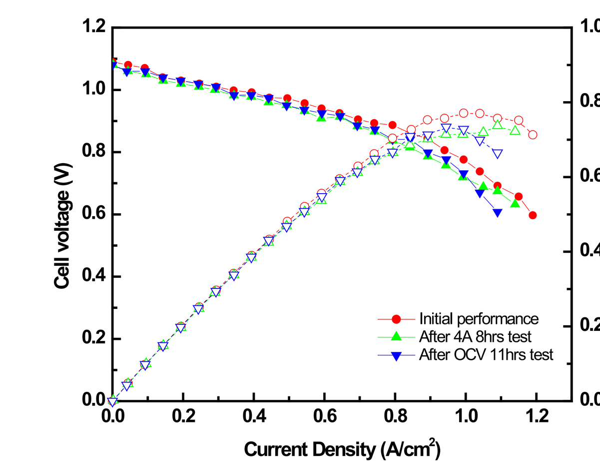
Pretreatment reduces impedance, increases surface oxygen, and decreases side reactions

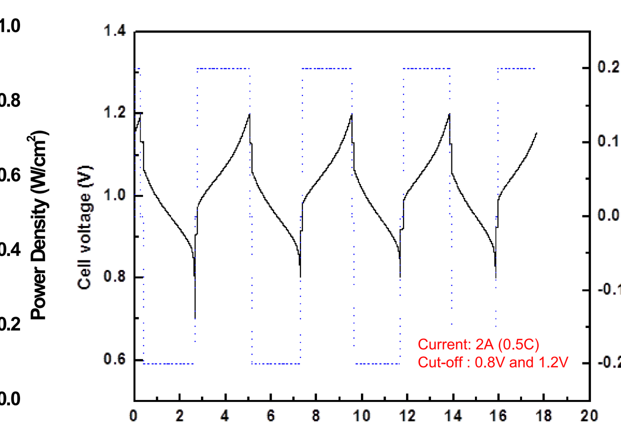






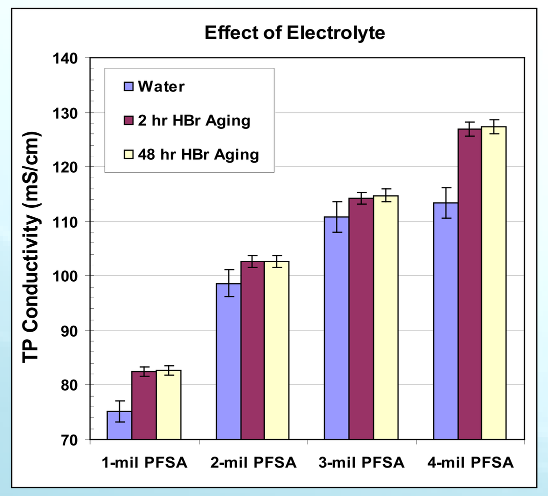
Good short-term durability but some capacity decay



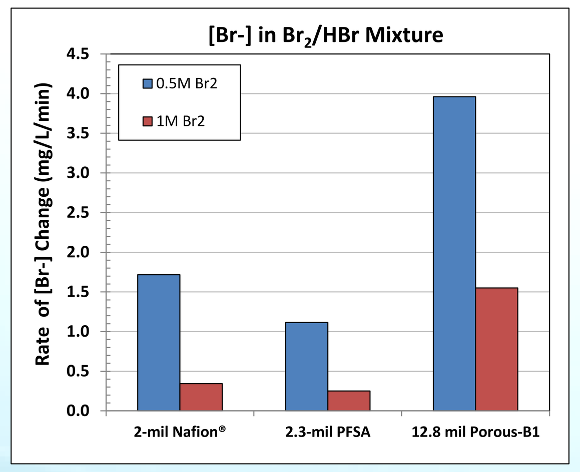


Membrane Development

Stability

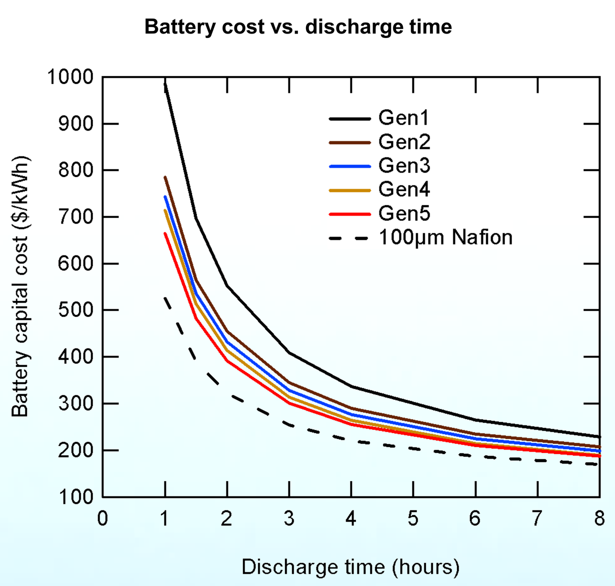


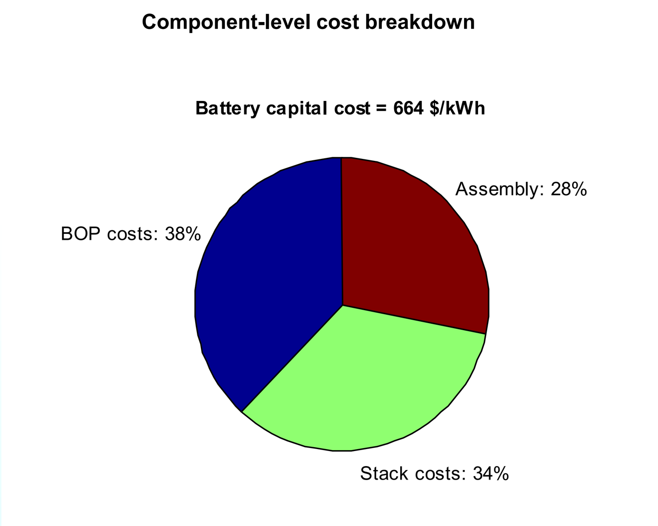
Br⁻ Crossover



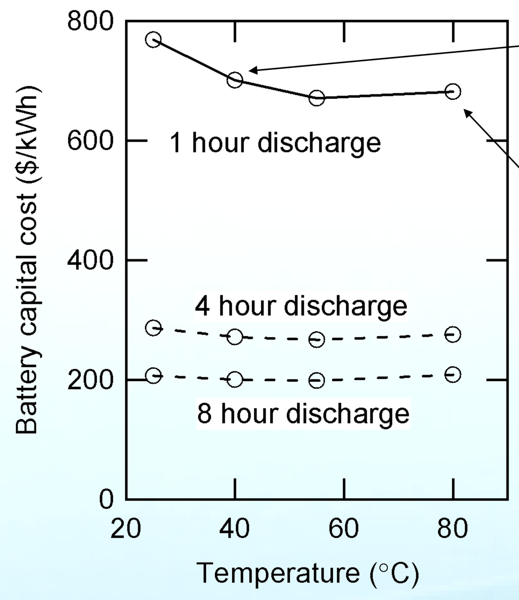
Modeling

System Costs





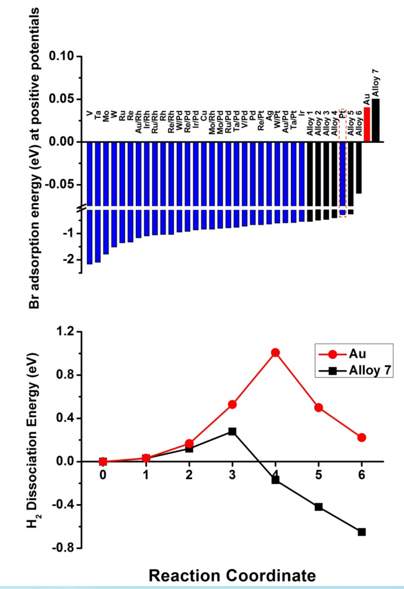
Performance Optimization



Below ~55°C the cost *falls* because the cell impedance is decreasing, leading to higher power at a given efficiency and a smaller (less expensive) stack

Above ~55°C the cost *rises* because the equilibrium potential is falling, leading to the reactants storing less energy

Bromine resistant catalysts



Acknowledgements

Funding from ARPA-E GRIDS, USDOE

LBNL: Kyu Taek Cho (Cell studies); Paul Ridgway (Catalysis studies); Sophia Haussener (Transport modeling)

Bosch: Paul Albertus (Cost Modeling); Roel Sanchez-Carrera and Boris Kozinsky (Catalyst theory)

DuPont: Biswajit Choudhury (New membranes)

3M: Mark Debe (Catalyst structures)

Proton OnSite: Kathy Ayers (Hydrogen compression, cost modeling)