JCESR | Joint Center for Energy Storage Research

Organic Avenue to Redox Flow Batteries

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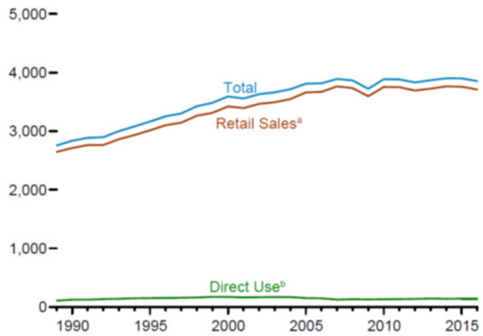
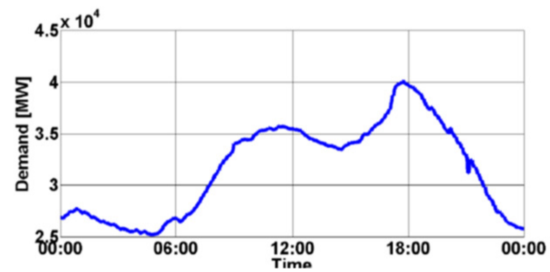
Additional Disclaimer (optional)

Smart Grid –Flow battery to enable the time domain

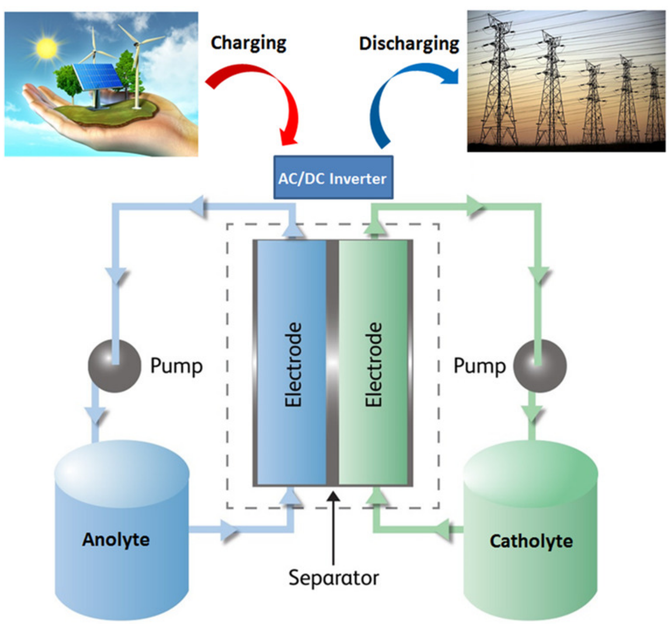
Figure 7.6 Electricity End Use
(Billion Kilowatthours)

Electricity End Use Overview, 1989–2016





Demand fluctuation



Benefits:

Decoupled energy (tank) and power (reactor)

Possible low cost

Large physical separation between oxidants & reductants

State-of-art RFB systems

Cathode-side: $VO_2^+ + 2H^+ + e^- \underset{\text{Charge}}{\overset{\text{Discharge}}{\rightleftharpoons}} VO^{2+} + H_2O$

Anode-side: $V^{2+} - e^- \underset{\text{Charge}}{\overset{\text{Discharge}}{\rightleftharpoons}} V^{3+}$

Cell reaction: $VO_2^+ + V^{2+} + 2H^+ \underset{\text{Charge}}{\overset{\text{Discharge}}{\rightleftharpoons}} VO^{2+} + V^{3+} + H_2O$

~25 Wh /L

$650/KWh

Cathode-side: $Br_2(aq) + 2e^- \underset{\text{Charge}}{\overset{\text{Discharge}}{\rightleftharpoons}} 2Br^-$

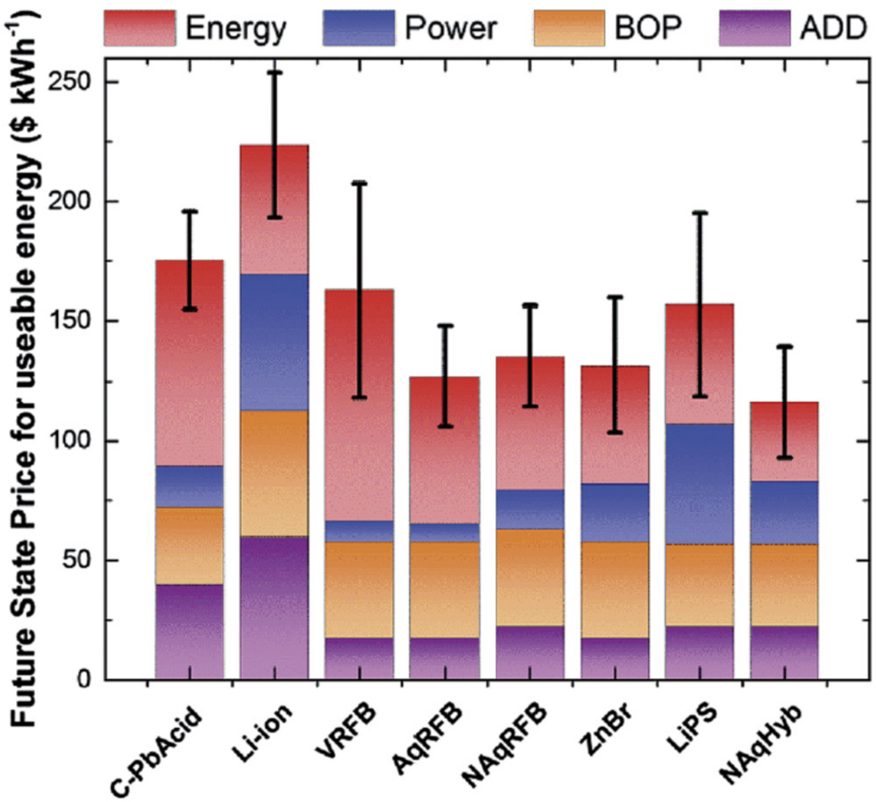
Anode-side: $Zn - 2e^- \underset{\text{Charge}}{\overset{\text{Discharge}}{\rightleftharpoons}} Zn^{2+}$

Cell reaction: $Zn + Br_2(aq) \underset{\text{Charge}}{\overset{\text{Discharge}}{\rightleftharpoons}} Zn^{2+} + 2Br^-$

~35 Wh /L

$550/KWh

Cost analysis of flow batteries and hybrid flow batteries



Energy Environ. Sci., 2014, **7**, 3459–3477

Assumption for flow batteries:

Nonaqueous: 3V, $5/kg
Aqueous: 1.5 V, $1/kg

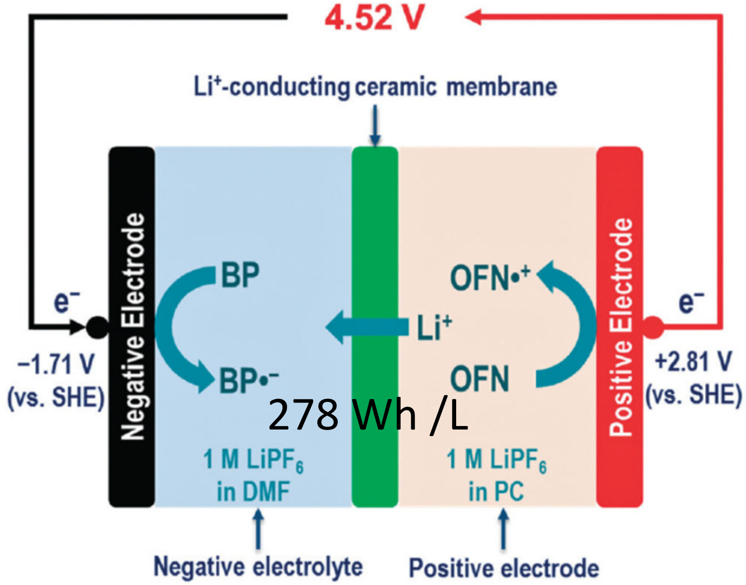
$$E \propto nFV_{cell}C_{active}$$

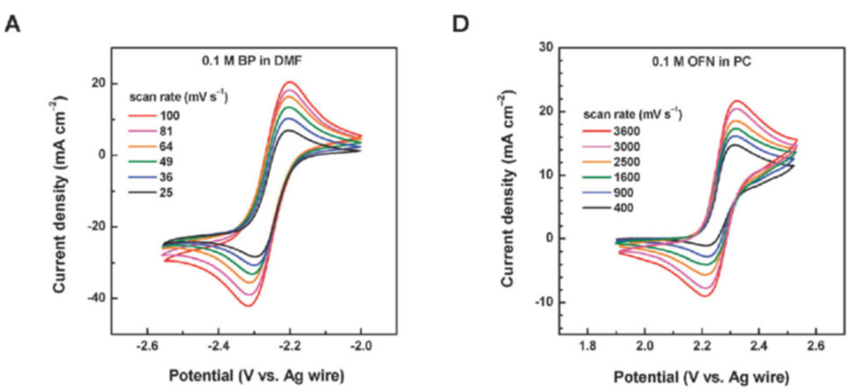
n - number of electrons transferred

V_{cell} - cell voltage

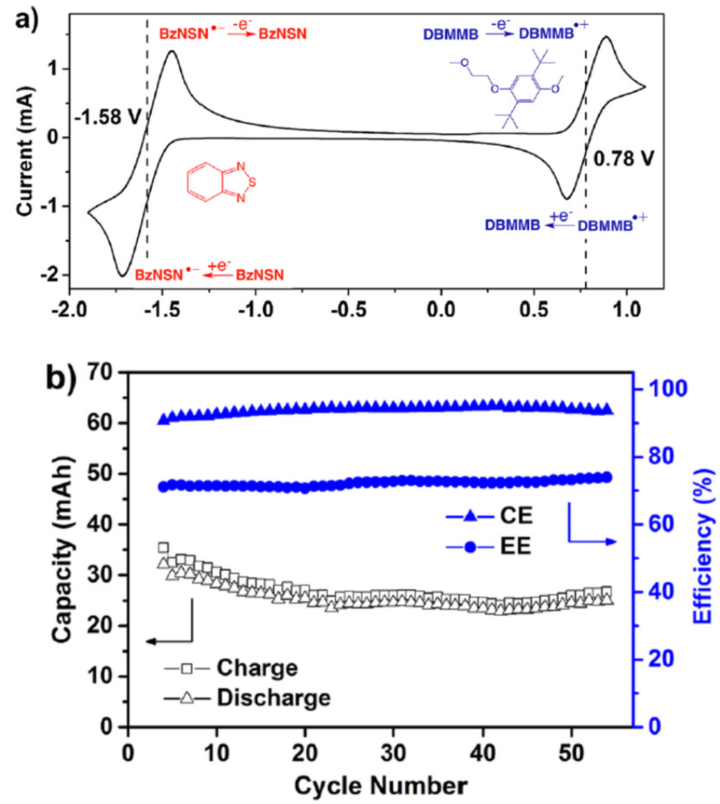
C_{active} - active species concentration

Nonaqueous flow batteries





Energy Environ. Sci., 2015, **8**, 3515–3530



Synthetic cost is over 95% and has a lot of room to reduce

ACS Energy Lett. 2017, 2, 1156−1161

Molecular roadmap for achieving high energy fuels