ITN Energy Systems, Inc., Littleton, CO

2.5kW/10kWh Redox Flow Battery (RFB) with Low-cost Electrolyte and Membrane Technologies

$2.1 M, 33-month program awarded by ARPA-E Sept 7, 2012

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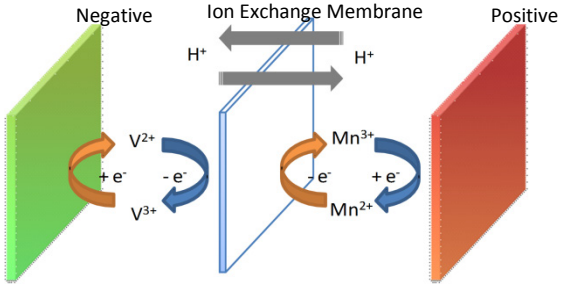
Technology Summary

- *Innovative, high energy density Mn-V based RFB electrolytes as a low-cost alternate to all-Vanadium systems*
- *Low-cost membrane technology, based on renewable biopolymer Chitosan with improved proton conduction & chemical stability, adaptable to Mn-V system*
- *Scale-up of electrolyte and membrane technologies in pursuit of ARPA-E's goal for a 2.5kW/10kWh RFB stack with integrated BoS at a total cost of ~$1000/unit and ~1.2 m^3 footprint*

Technology Impact

Cost-effective & reliable Mn-V RFB technology as a direct response to multiple end user demands for grid-connected energy storage and deployment, for which the international market is expected grow to ~$11 B by 2016

ITN program's 2.5kW/ 10kWhr RFB device



ITN program's low-cost Mn-V system with >20% volumetric energy density over all-Vanadium RFB

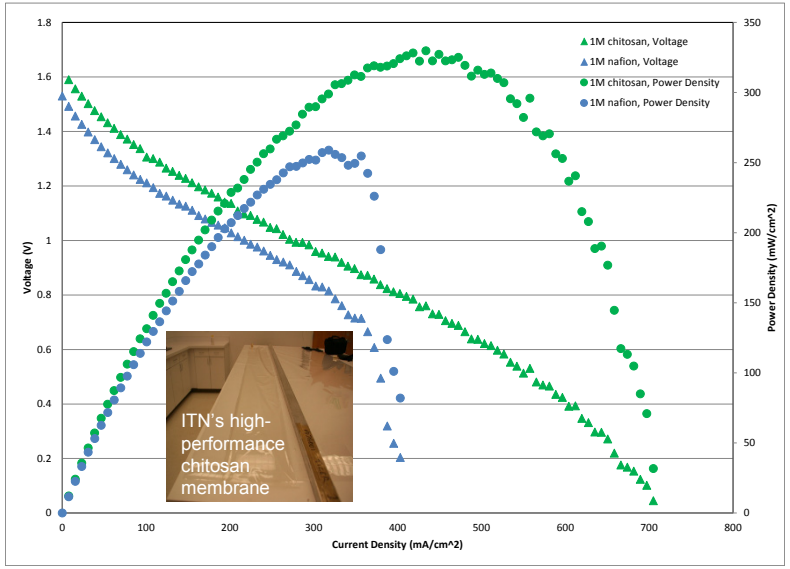
Program Targets

Phase I (9 months): Demonstrate a ~150 cm^2 active area flow cell with OCV > 1.7V; discharge voltage >1.5V; efficiency > 80%; and peak power density >500mW/cm^2

Phase II (24 months): Demonstrate RFB system with OCV > 1.7V; discharge voltage >1.5V; efficiency > 80%; and peak power density >750mW/cm^2; capacity of 10kWh; cycle life >30 cycles

Metrics	State of the Art (VRFB)	ITN/UKy's Mn-V RFB
Power Density (mW/cm^2)	*300*	*750*
System Cost (2.5kW/10kWh)	*$2,200*	*$1,100*
Round Trip Efficiency	*80%*	*>80%*
Stack Materials	*$890**	*$210*
Electrolyte Cost	*$780**	*$456*

**Data based on publicly available sources*



Superior performance of ITN's Chitosan over Nafion® membranes in VRFB

High-Performance, Low-cost RFB through Electrolyte & Membrane Innovations