



# Sodium Intercalation Battery for Stationary Storage

## Energy Storage Systems Program (ESS) Peer Review and Update Meeting 2012

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**Large-scale stationary energy storage for integration with renewables and for off-peak energy capture is a new application requiring new rechargeable batteries.**

- New combination of requirements
  - Long cycle life under deep cycling use profile
  - High cycling efficiency
  - Moderate rate capability
  - Very low cost
  - **No** requirement for particularly high specific energy or energy density
- TIAX is developing a novel Na-ion battery
  - Leverages teachings of Li-ion technology
  - Targets novel low-cost chemistry and cell design
- TIAX has an ongoing Phase I SBIR program
  - contract # DE-SC0006457

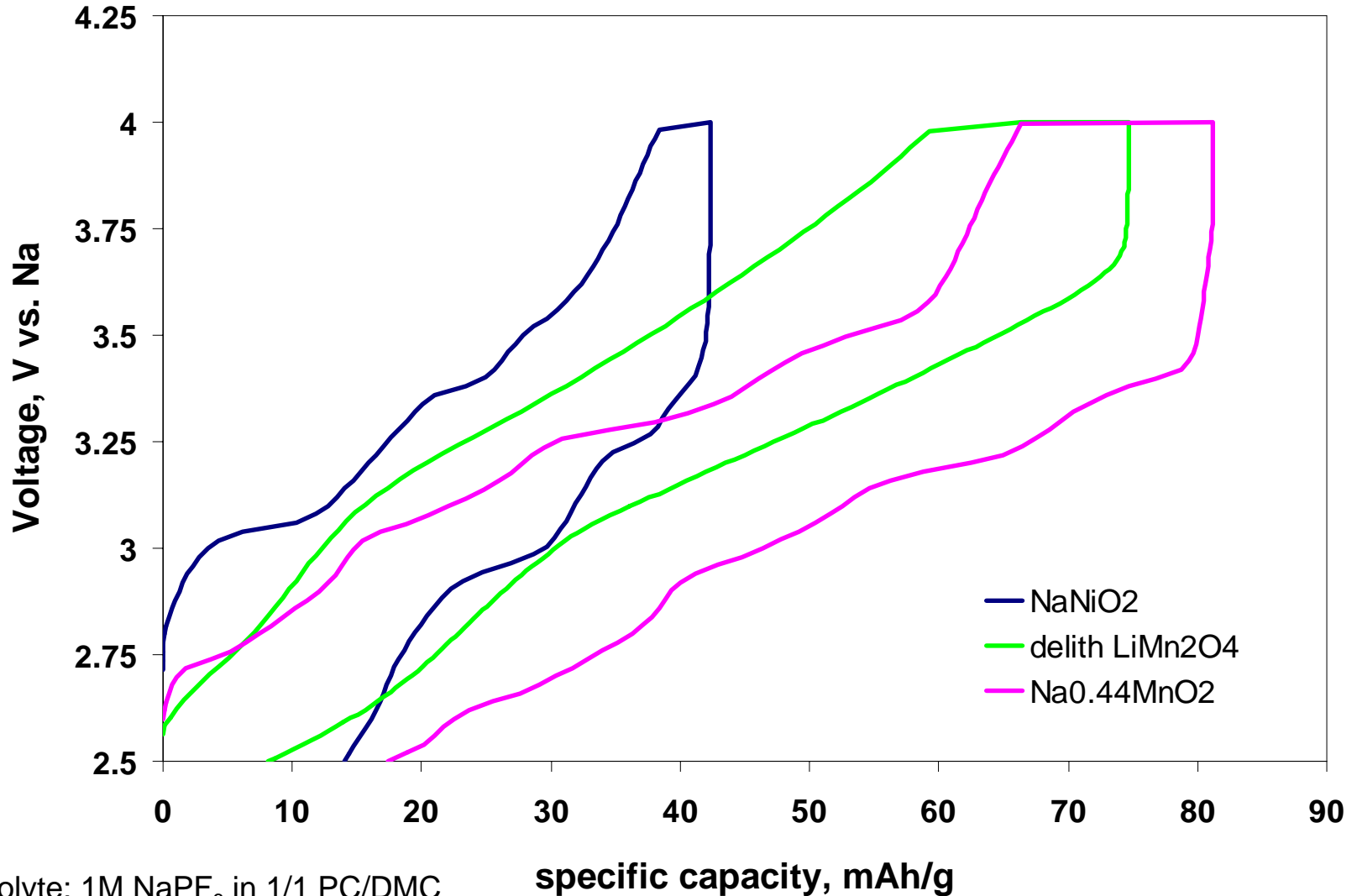
**TIAX is integrating elements of other technologies for this energy storage application.**

- Screen materials vs. Na metal counter-electrode in Na<sup>+</sup> salt-based organic electrolyte
  - Evaluate known Na-ion active materials
  - Evaluate Na analogues of Li-ion active materials
  - Pair anode and cathode materials for combining in Na-ion cells.
- Formulate Na<sup>+</sup> electrolyte for enhanced Na-ion performance.
- Formulate electrodes for enhanced performance in Na<sup>+</sup> electrolyte.
- Demonstrate baseline cell chemistry.
- Develop scaled-up cell designs and rough cost estimates.
- TIAX has an ongoing Phase I SBIR program
  - contract # DE-SC0007475.

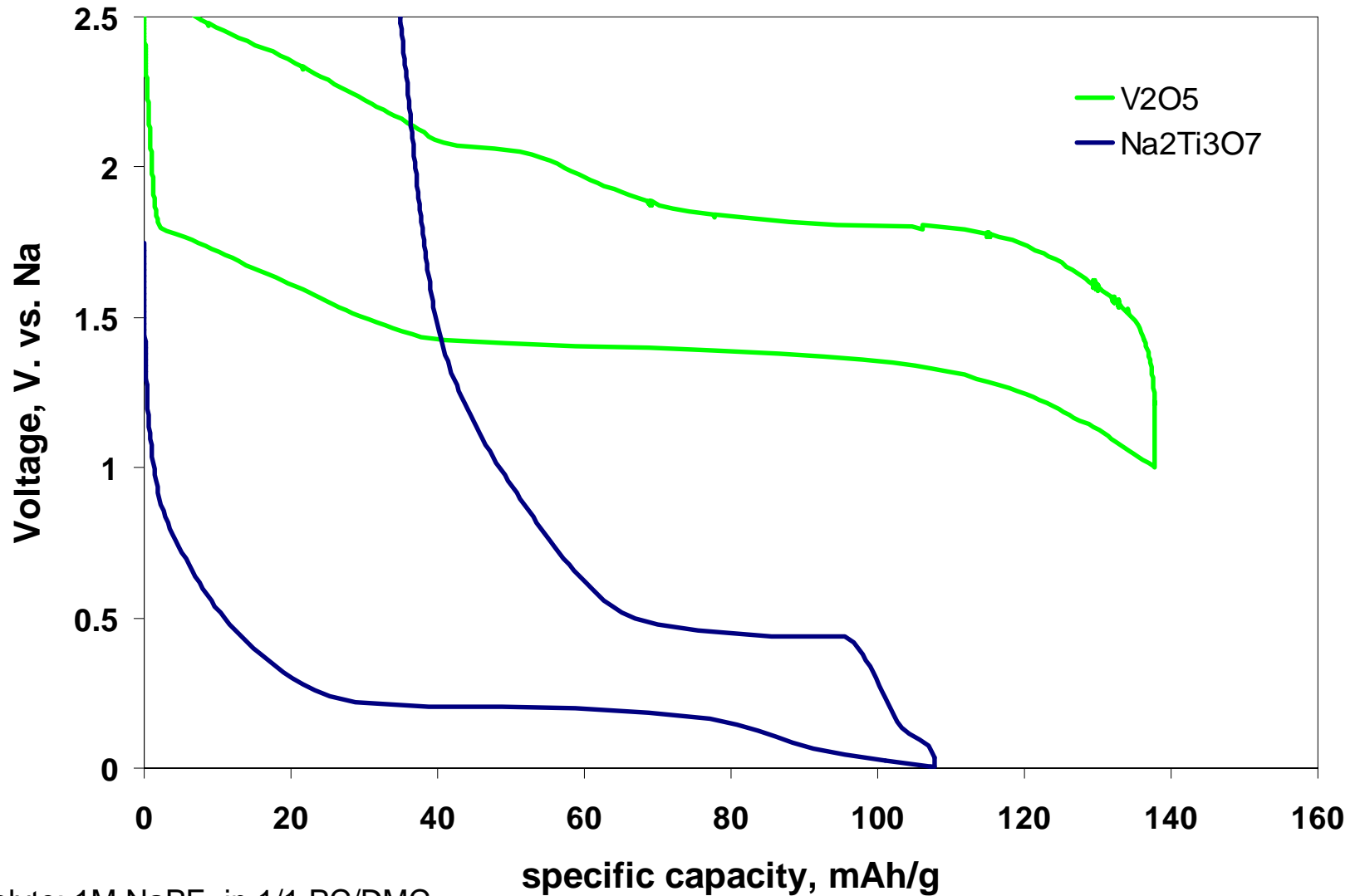
Initial anode and cathode materials have been cycled vs. Na metal in organic Na<sup>+</sup> electrolyte.

material	average potential V vs. Na	specific capacity mAh/g
<i>cathodes</i>		
Na <sub>0.44</sub> MnO <sub>2</sub>	3.2	65
NaNiO <sub>2</sub>	3.1	30
delith LiMn <sub>2</sub> O <sub>4</sub>	3.4	70
<i>anodes</i>		
Na <sub>2</sub> Ti <sub>3</sub> O <sub>7</sub>	0.32	90
V <sub>2</sub> O <sub>5</sub>	1.6	140

Cathode materials investigated to date cycle at slightly lower potentials than their lithium analogs ( $E^{\text{Na}/\text{Na}^+} = 0.25\text{V}$  vs.  $E^{\text{Li}/\text{Li}^+}$ ).



Possible anode choices span a broad range of cycling potentials.



Electrolyte: 1M NaPF<sub>6</sub> in 1/1 PC/DMC

**Our Phase I SBIR program is now entering into tests of full cell chemistries.**

- Candidate active materials screened
  - Additional candidates are still on test.
- Electrolyte formulation experiments are underway.
- Na-ion cell experiments are beginning.