APS Energy Storage and EV Programs

John Pinho
Customer Technology
May 2017

Agenda

- Utility Scale Energy Storage
- Residential & Commercial Energy Storage
- Lithium Ion Battery Features
- Electric Vehicle Plans

Energy Storage for SPP

- Designed to improve power quality on high penetration solar PV feeders (high voltage; low power factor)
- Two identical systems:
  - One located near substation (Surprise)
  - One located at end of feeder (Buckeye)
- Each system is 2MW/2MWh in size
- In service since December 2016
- 18 month evaluation to determine impact of where on feeder provides best power quality improvement

Energy Storage for Reliability

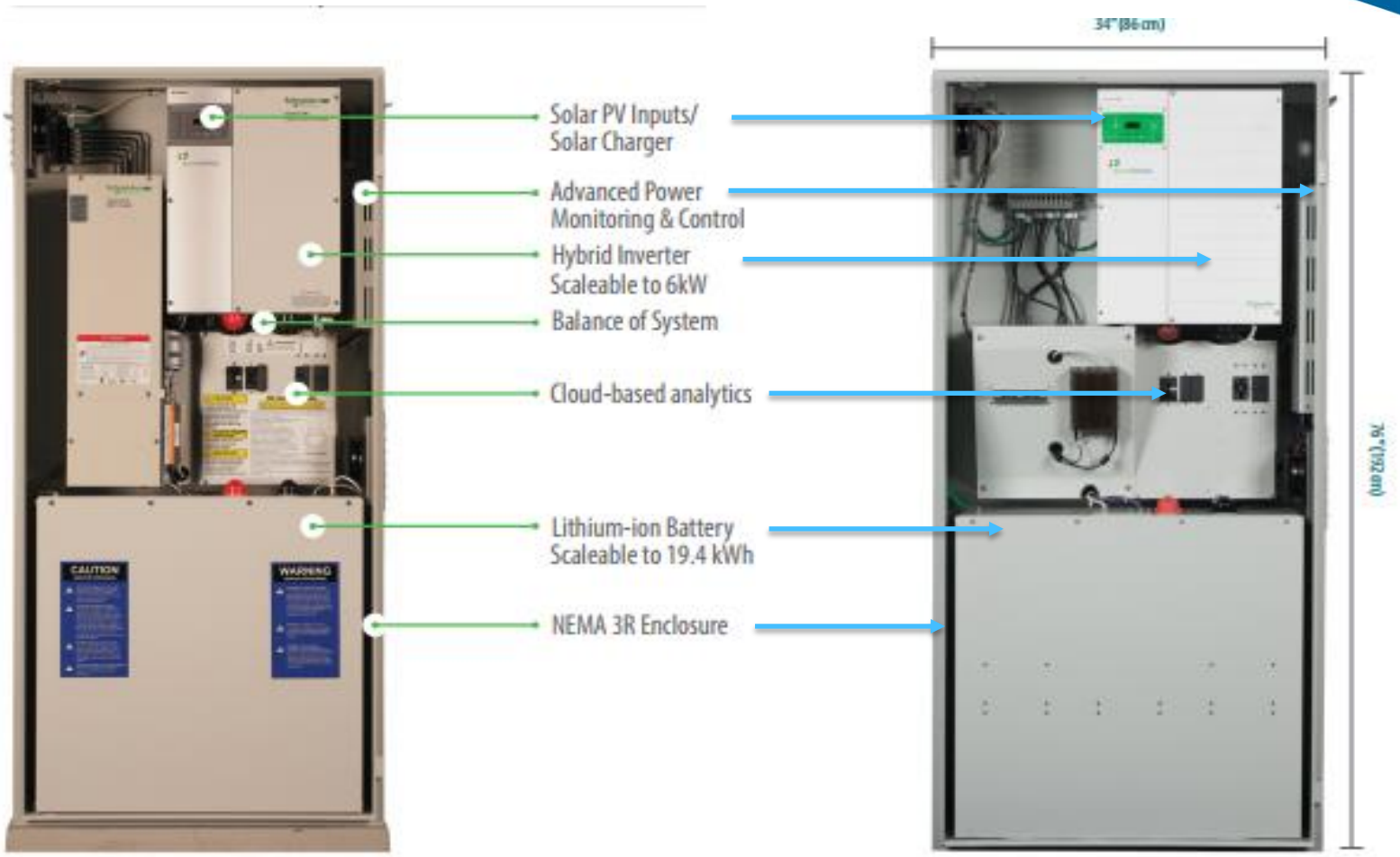
- Alternative to replacing existing 22kV feeder
- 2MW/8MWh in size (each system is 2MW/4MWh)
- In service as of March 2018
- Site designed for future expansion

Residential & Commercial Energy Storage

Residential ES
5kW/20kWh

Commercial ES
200kW/400kWh

Sunverge Residential System



DC Coupled

AC Coupled

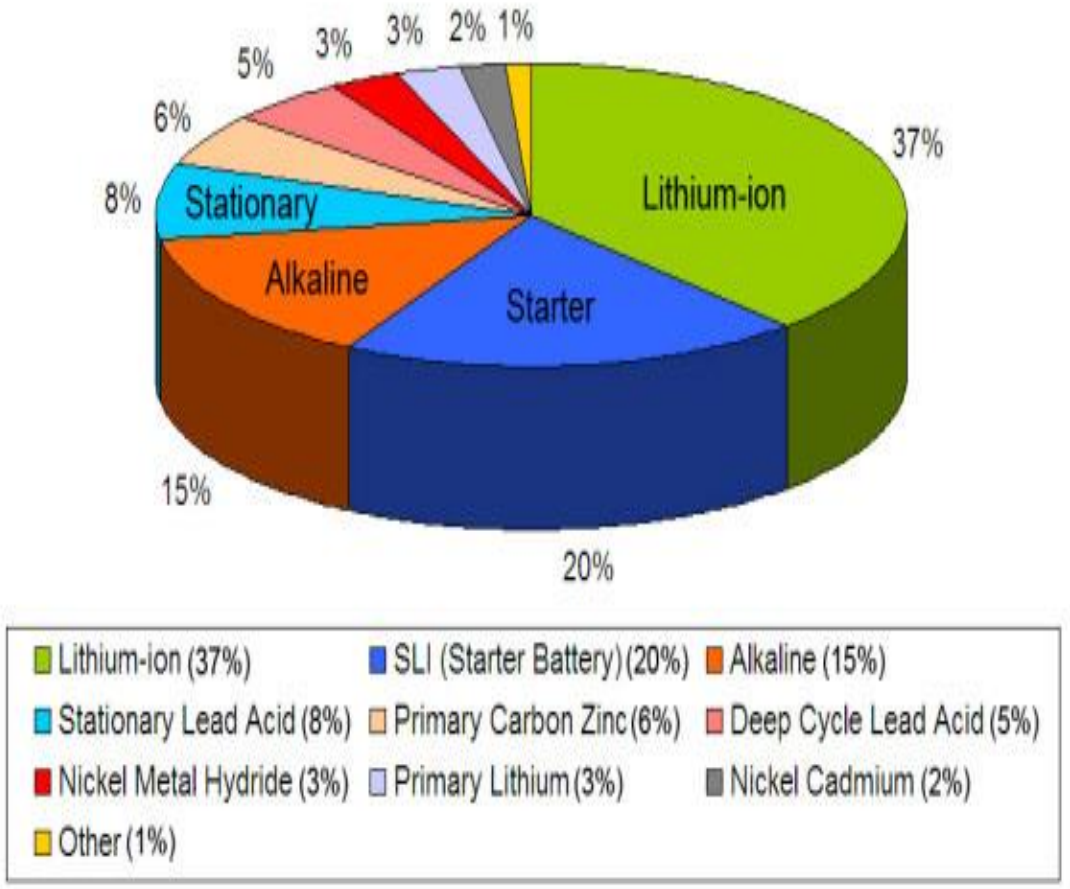
How does a Lithium Ion Battery (LIB) work?

- Lithium ions are generated in the cathode (blue) and migrate through the electrolyte/separator (White) to the anode (black) during charging and are stored
- The ions migrate back to the cathode during discharge and in doing so, generate a DC electrical current

Lithium Ion Battery Comparison

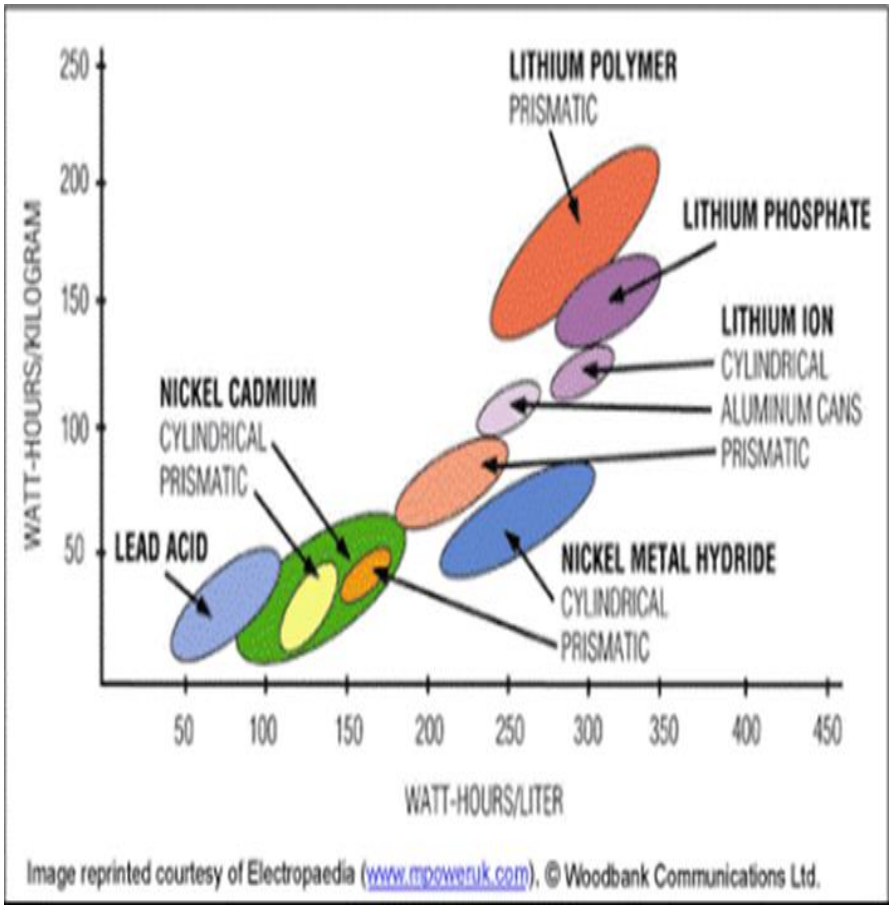
Key features compared to other rechargeable battery types:

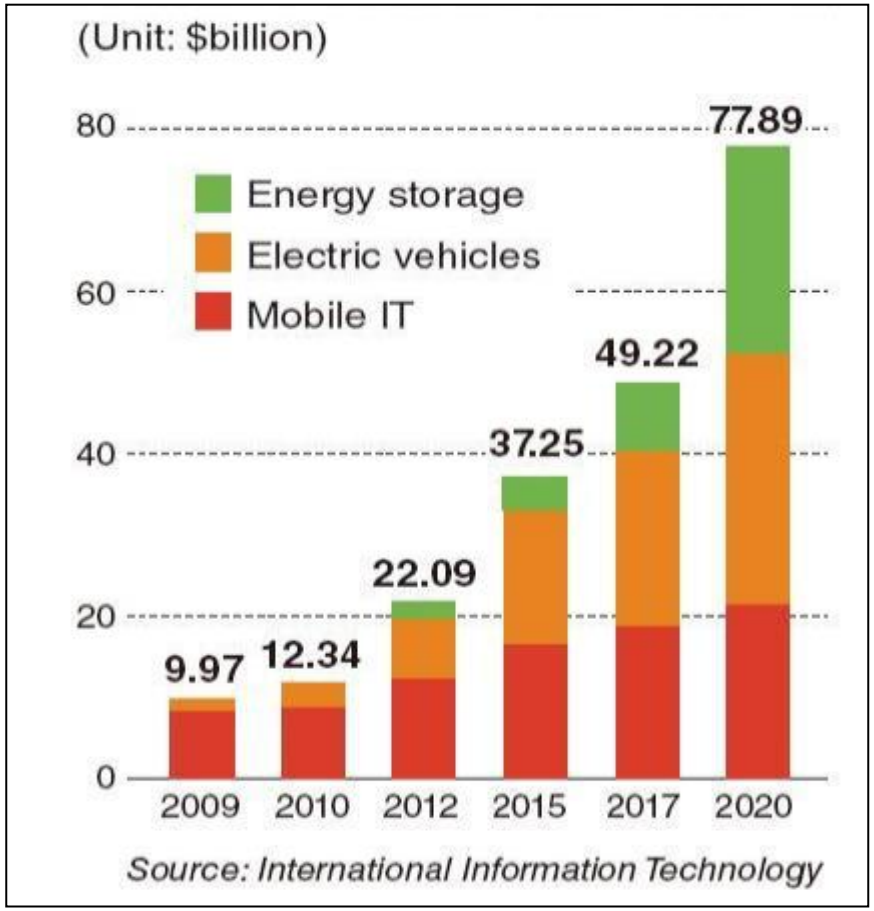
- Half the weight
- Half the size
- Higher cell voltage
- Long life cycle
- Deep depth of discharge
- Fast charge capacity
- No metallic lithium
- No memory effects
- Low pollution impact



Why Lithium Polymer Batteries?

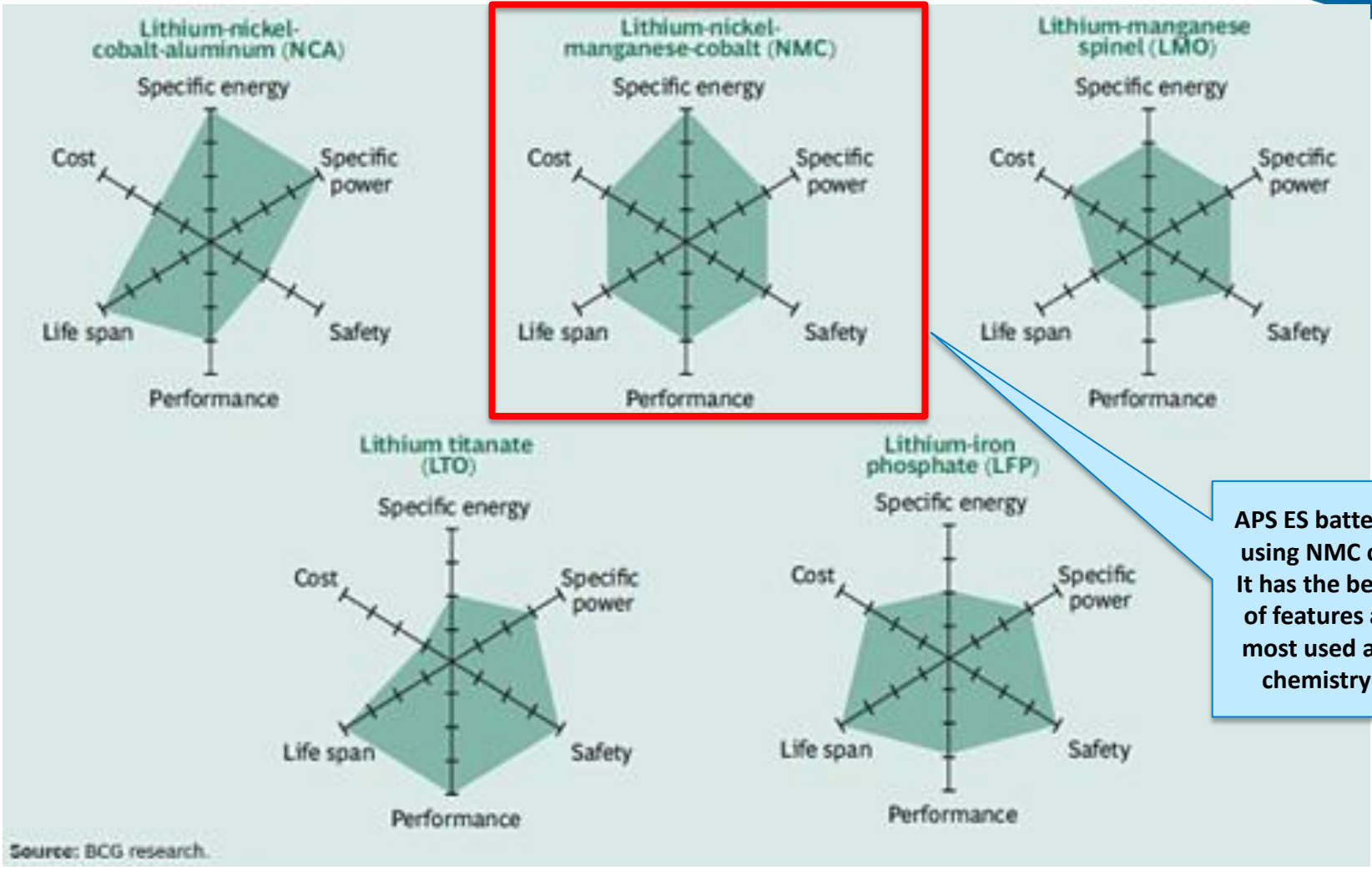
Best combination of capability and cost due to demand and scale of EV market.





Note: There are a number of different chemistries that make up the Lithium Polymer family of batteries

Different Lithium Battery Chemistries



APS ES batteries are all using NMC chemistry. It has the best balance of features and is the most used and tested chemistry for EV's

Battery University 2012

UL9540 2nd Edition

- Covers all types of Energy Storage
  - Includes lead acid; lithium ion; flow batteries; fly wheels and pressurized systems
  - Applies to both stationary and mobile battery systems
  - Requires compliance with:
    - UL1642 – Cells (individual batteries)
    - UL1973/IEE1547 – Modules and Packs (groups of cells)
    - UL1741 SA – Inverters (includes Supplement A)
    - NFPA 70/IEEE C2 – Electrical systems
    - IEC 61508/IEC 60730-1/UL991/1998 – Functional Safety
    - NFPA 855

EV Plans

Pending ACC review and approval:

- Incentive for homebuilders to pre-wire garages for EV chargers ($100/home)

- Fleet, Workplace and Multi-tenant building
  - No customer up front costs
  - APS provides all equipment and infrastructure
  - Level 2 charging stations
  - Special rate to recover costs over time

- Electric School buses for Low Income Districts
  - Provide buses and infrastructure at no cost to school
  - Replacing existing diesel buses
  - Ability to use battery as "solar sponge"