



# Advancements in Lithium Ion Batteries

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World Class. American Made.

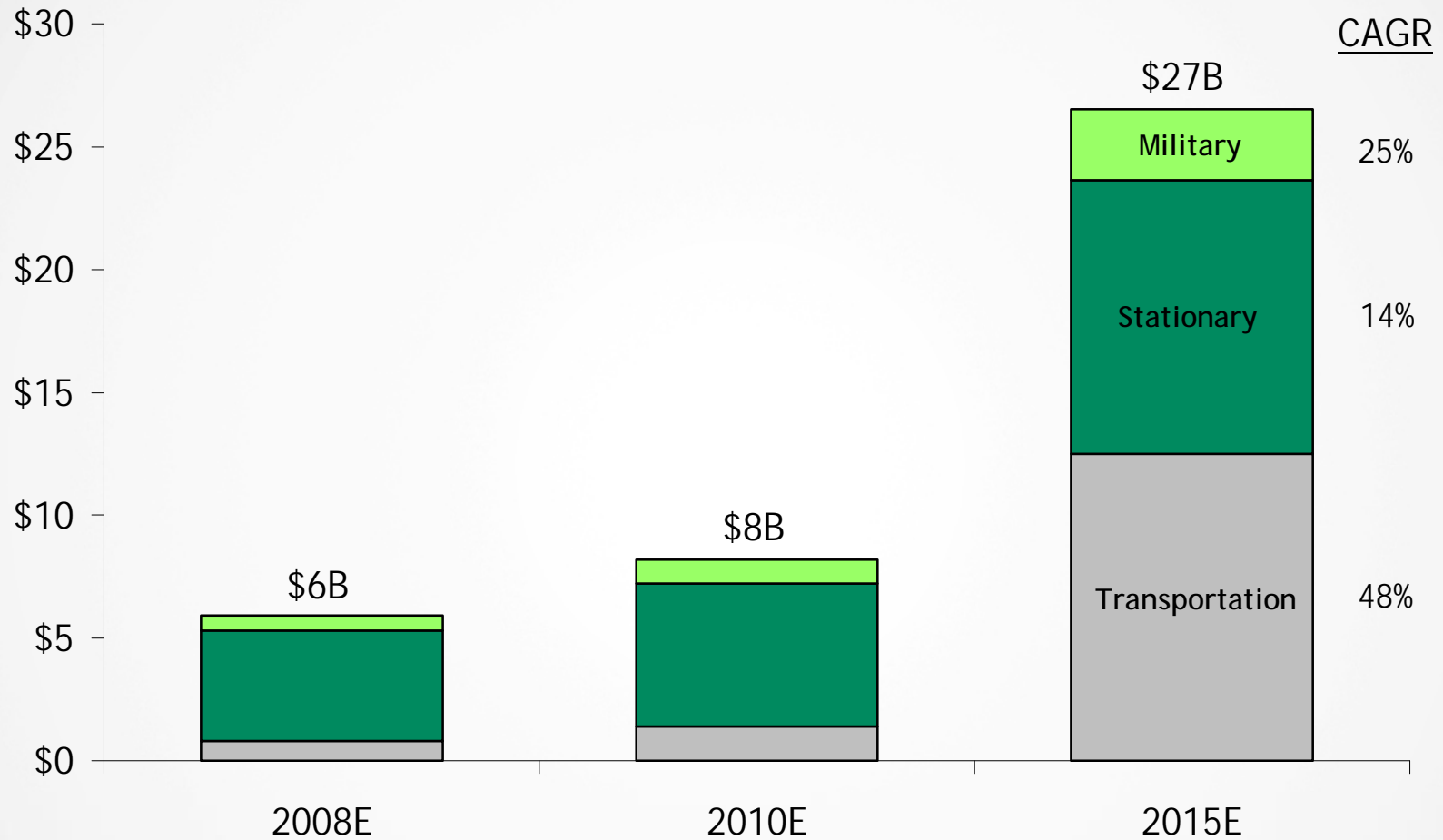
# Company Overview

- Large format lithium ion prismatic cells and batteries
- Founded 2004
- Headquarters & plant - Allentown, PA
  - 92,000 sq ft facility
  - State-of-the-art laboratory and testing facilities
  - Current capacity 20,000 kWh/year, expansion capacity to 120,000 kWh/year
- Unique, environmentally friendly water-based manufacturing process



# Market Forecast (\$B)

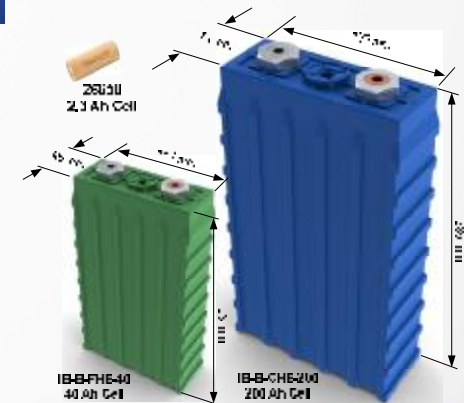
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Sources: CLSA, Deutsche Bank, Frost & Sullivan, Lux Research, Company Estimates.

# Areas of Advancement

- Chemistry and Materials
- Manufacturing Process
  - Water-based
- Format
  - Large Format prismatic cells



# Large Format Prismatic Cells

## “When Energy Really Matters”

### Lithium Nickel Cobalt Manganese



185 Wh  
3.7V, 50 Ah



333 Wh  
3.7V, 90 Ah



740 Wh  
3.7, 200 Ah

### Lithium Iron Phosphate



128 Wh  
3.2V, 40 Ah

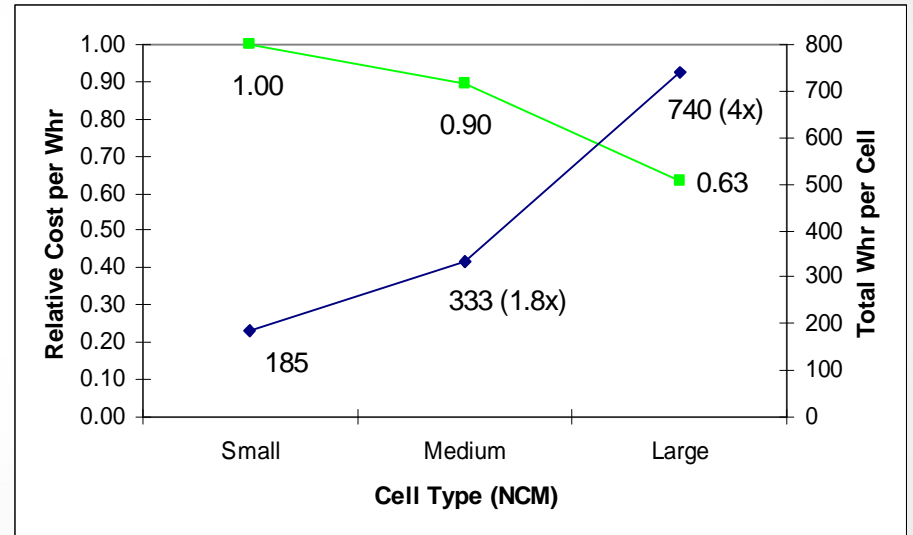


192 Wh  
3.2V, 60 Ah



512 Wh  
3.2V, 160 Ah

### Economy of Scale



# *Energy Storage for the Smart Grid*

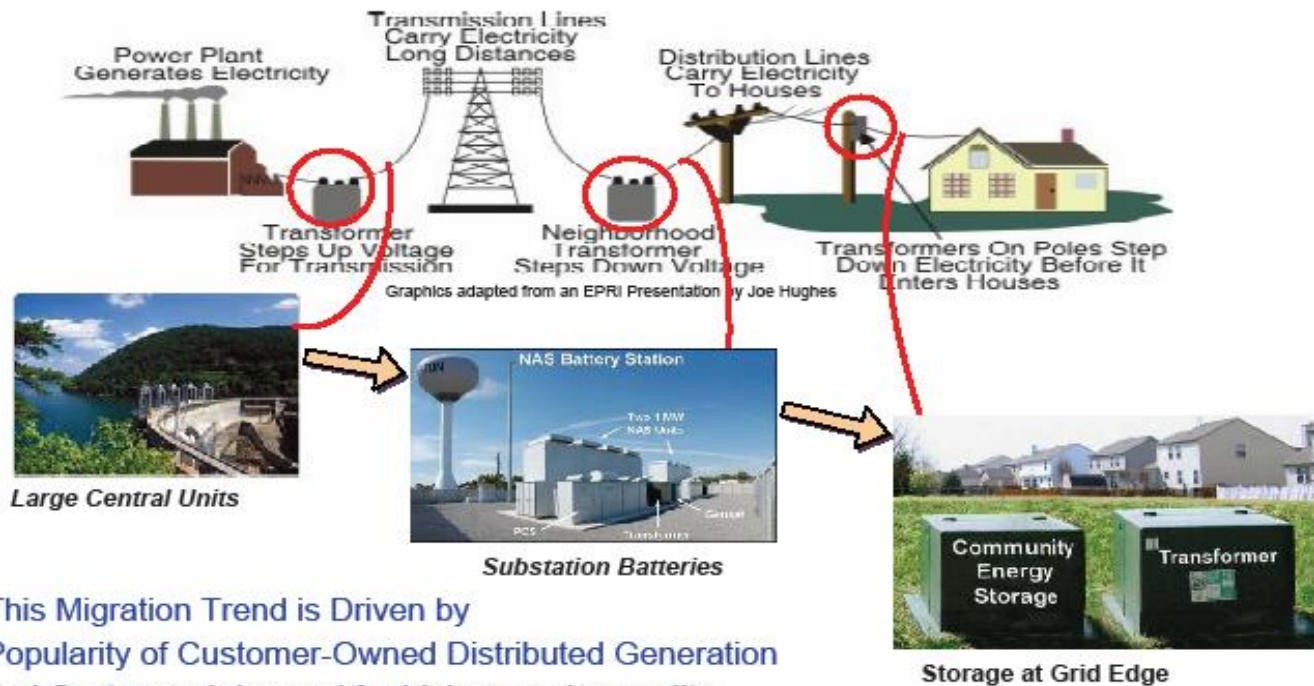
# Why is Storage Needed?

- International Comparisons
  - Japan 15%
  - Europe 10%
  - United States 2.5%
- Increasing renewable integration



# Where is Storage Needed?

## Migratory Path of Utility Energy Storage – in AEP





# Many Storage Options

- Pumped hydro, CAES, flywheels
- Batteries
  - Lead acid, sodium sulfur, lithium ion



- Why Lithium Ion?
  - 98-99% Efficiency
  - 50 msec response time
  - Energy Density
  - Scalability to > 1 MWhr
  - Enables Multiple Services
  - Cost Reduction Roadmap (Adoption by other industries)
  - Continuous Investment and innovation



# Distributed Energy Storage (Li-Ion: 50KWh in a pad mounted enclosure)

- q Energy Capacity from 50 KWh - 150KWh
- q Tailored to the location and duty cycle
- q No/low maintenance
- q Multiple configurations  
(*inverters, chargers, switching hardware, etc*)



International Battery Prototype

# Summary

- Need for Energy Storage increasing dramatically
- Care must be taken to match the application requirements to the storage technology
- Li-Ion batteries are proving to be a versatile solution
- Industry partnerships are the key to make this happen

Thank you !!

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