# The Power You Need

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### Agenda

- East Penn & Navitas Systems overview
- Battery technologies
- Battery performance
- The right battery for the right application
- Sustainability
- East Penn Your energy storage solution provider



# East Penn Overview



# East Penn Today

- Largest single-site and largest privately-held battery company
- 3 U.S. Battery manufacturing locations
  - Lyon Station, PA 520 Acres
  - Ann Arbor, MI
  - Corydon, IA
- Vertically integrated
- Quality culture
- Investment in our people
- Over 70 years in the industry
- Single source technology solutions

#### 10,000+ Employees Globally





#### DEKA North American Dealer/Support Network

Our strength is in the Deka Network's ability to provide the technologies, products, & support to optimize customers' operations



# Navitas Systems Overview

- Family owned company founded in 2012 with two generations in place.
- Headquarters: Woodbridge, IL
- R & D/Government Work: Ann Arbor, MI
  - 48,000 sq. ft.
  - 60 scientists & engineers
  - 100 + employees
- Battery manufacturing: Ann Arbor, MI
  - 100,000 sq. ft.
  - 50 + employees
- East Penn acquired majority share in 2019





# Battery Technologies



### Lead Battery Chemistry

- Two unlike metals in acidic solution
  - Positive plate = PbO<sub>2</sub> lead dioxide
  - Negative plate = Pb lead
  - Electrolyte =  $H_2SO_4/H_2O dilute$  sulfuric acid





### Lead Battery Chemistry

- Technology types
  - Flooded Electrolyte that is liquid based.
  - Absorbed Glass Mat A glass microfiber separator absorbs and retains the electrolyte in direct contact with the plate.
  - Gel Electrolyte which has been immobilized by addition of silica powder or other gelling agent.



### Li-ion Cell Chemistry



# **Battery Performance**



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#### **Understanding Lead & Lithium Batteries**



#### Performance Characteristics of Lead Batteries

#### **1000 AH capacity, 36 Volt Example**

- We can use 80% or 800 AH over six hours
- For heavy and/or high lifting the truck consumes more amps
- Lead batteries are impacted by the rate of discharge
  - Think of a mix of drive and lifting

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• Think "put away" or, "elevator" operations

Key Point: The greater the amps consumed, the fewer available AH



#### Performance Characteristics of Lead Batteries

#### **1000 AH capacity, 36 Volt Example**

- Conventional batteries are rated at 1 EBU per day
- Opportunity charge batteries are rated at 1.25 EBUs per day
- Fast charge batteries are rated at 1.6 EBUs per day

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**Key Point:** 

Equivalent Battery Unit (EBU) is defined as one discharge to 80% depth of discharge



#### 1000 AH Lead Battery Dynamic Discharge



-Current ---- Battery Voltage

#### Performance Characteristics of Lithium Batteries

- Lithium batteries are not influenced by the rate of discharge
  - If a battery is rated at 700 AH the battery can be:
    - Discharged at 560 amps for one (1) hour
    - Discharged at 280 amps for two (2) hours
    - And so on...

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Key Point: The lithium battery will deliver full useable AH



# Performance Characteristics of Lithium Batteries

#### **1000 AH capacity, 36 Volt Example**

- Our lithium equivalent battery will be measured in AH throughput
  - The battery is rated at 700 AH
    - We can use 80% or 560 AH
  - Regarding AH throughput...
    - The key focus with lithium is kWh throughput
      - As a result of higher discharge voltages, less Amps are required, and less AH
    - The kWh throughput is about 65,000 kWh
    - This is about 55% more lifetime kWh than the PSOC lead battery



#### Lithium Battery Dynamic Discharge



-Current -Battery Voltage

2020

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#### How Does the Truck React to a Battery?

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 During discharge, the lithium battery voltage does not decrease as much as lead





# The Right Battery for the Right Application



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# Finding the Right Power Solution

- Understand your operations, costs, duty cycles, and goals
  - Site survey
  - Power study
- Deliverables
  - Performance modeling
  - Maintenance modeling
  - Financial modeling
  - Life modeling



# **Application Analysis**

- Factor in each aspect of the process:
  - Acquisition and installation
  - Productivity
  - Charging
  - Changing
  - Maintenance
  - End of life
  - Duty cycle
  - Temperatures

- Power Study
  - Temperature of operations
    - Discharge & recharge
  - Duty cycle
    - AH throughput & rate of discharge
    - Time to recharge and equalize
  - Cables & connector(s) single or double
  - Life
    - Ampere Hour (AH) throughput, years of service
    - Depreciation schedules



# Understanding the Big Picture

- Needs are many and varied
  - One or two shifts
  - Cold storage
  - Three shifts
- There's no single technology that serves all applications
  - The goal is to identifying all the business case dimensions and apply the right solution(s)



# Determining the Best Solution

- Both lead and lithium batteries have applications, performance, life, and maintenance differences
  - Lead Batteries
    - Low cost
    - Wide ranging applications
    - Proven technologies
      - Conventional or Partial State of Charge
    - Affordable to very low maintenance
    - Efficient recycling streams

- Lithium Batteries
  - Higher initial acquisition cost
  - Partial state of charge
  - Higher discharge voltages
  - Very low maintenance
  - Highly efficient recharge



# **Applications Targets and Summary**

- Lead "shines" in
  - Initial cost
  - Conventional and PSOC charging applications
    - ≤ 1.6 EBU's per day
  - Multiple shifts
  - Flooded and maintenance free

- Lithium "shines" in:
  - Cold storage applications
  - High AH throughput
    - >1.6 EBU's per day
  - Multiple shifts
  - Customers desiring zero
     watering
  - Customers desiring zero equalize charging



#### **Financial Modeling**

- Comparison of the total cost of ownership of both lead and lithium batteries
  - Acquisition
  - Operations
  - Maintenance
  - End of life

- Financial analysis
  - To determine the value of the financial investment of the technologies
    - Return on Investment (ROI) Payback period
    - Internal Rate of Return (IRR) What is the "Interest Rate" of the investment
    - Net Present Value (NPV) Consolidation of the costs, savings, and value of the saving
    - Total Cost of Ownership (TCO) Entire cost over the life of the project

# **TCO** Comparison

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#### Key factors:

- AH throughput
  - 1.2 lead EBU's
- Shifts per week
  10 shifts
- Cost of electricity
  - \$.06 kwh
- Fully loaded operator costs
  - \$22.50 PH/PP
- Battery fleet size
  - 150 batteries



# **TCO** Comparison

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#### Key factors:

- AH throughput
  - >1.6 lead EBU's
- Shifts per week
  18 shifts
- Cost of electricity
  - \$.08 kwh
- Fully loaded operator costs
  - \$70 PH/PP
- Battery fleet size
  - 226 batteries



# Battery Solution Development – Lead & Lithium

- Compare and contrast both technologies :
  - Acquisition and installation
  - Cycle life
  - Charging
  - Changing
  - Maintenance
  - End of life

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Key Point: Make the data driven solution that is optimal for the customers' needs



# Sustainability



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# End of Life Solutions - Lead LEAD BATTERIES ARE



' National Recycling Rate Study, Battery Council International, 2017

LEAD BATTERIES



are the MOST RECYCLED PRODUCT in the United States<sup>1</sup>

<sup>1</sup> Advancing Sustainable Materials Management: 2014 Fact Sheet, Environmental Protection Agency, Nov. 2016



#### End of Life Solutions – Lithium

#### • Current lithium end of life solution:

- Many elements can be reused/recycled
  - Counterweight tray Steel
  - Battery pack case Steel
  - Cables Copper
  - Hardware Steel

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Key Point:

East Penn is committed to receiving all Deka Ready Power units back at the end of their life for proper disposal.

# East Penn – Your Energy Storage Solution Provider



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#### We are Specialists

- Lead and lithium battery specialists
- Focused on providing factual data for various power solutions
- Sales tools, solution proposal development, ease of ordering
- Focused on helping you reach your material handling goals





#### **Product Attributes**

#### Lead

- Rugged flat plate design
- Proprietary oxide
- 5-step retention system
- Exclusive formation process
- Quality system

#### • Lithium

- Widest range of 24/36/48 volt products
- Exclusive
  - BMS
  - BMS software
- UL Listing
- Lithium iron phosphate chemistry
- Safety certified
  - UL drop test
  - Nail penetration



### Summary

- Find a partner who is committed to:
  - Provide reliable and powerful solutions
  - Provide financial solutions for our customers to consider
  - Provide a safe solution
  - Provide an end of life solution for both Deka lead and lithium batteries
  - Provide the tools to help customers optimize their operations





#### For more information:

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