



# Natron Energy

## Introduction

September 2023



# Introduction to Natron Energy

- **Mission:** To solve operations, reliability, and performance challenges for the world's largest electricity customers with advanced battery solutions
- **Products:**
  - High power, safe, sustainable batteries for in-rack and centralized power
  - Based on new chemistry: sodium-ion energy storage in Prussian blue electrodes
- **Stage:**
  - >2MW of batteries shipped to date
  - Shipping products from Santa Clara, CA production line
  - First mass manufacturing online Spring 2024
- **Company:**
  - Founded in 2012 as a Stanford spin out.
  - 180+ employees
    - Headquarters in Santa Clara, CA.
    - Manufacturing plant Holland, MI 600MW capacity



# As Seen on CNBC!

- CNBC profiled Natron Energy and one other sodium-ion battery manufacturer

*Click anywhere to visit the CNBC link*

VIDEO 13:58

**How sodium-ion technology will compete with lithium-ion batteries**

<https://www.cnbc.com/2023/05/10/sodium-ion-batteries-shaping-up-to-be-big-technology-breakthrough.html>

# Natron solves problems created by lead acid and Lithium-ion



**50,000-100,000**  
Cycle Lifetime



**Rapid Recharge**  
8-15 Minutes



**Certified**  
UL 1973 Approved



**Safe**  
No Fire Hazard



**Volume Production**  
Ready



**Secure Supply**  
Chain



**Environmentally &  
Socially**  
Responsible



**Safe for Air**  
Transport

## Safety Attributes

Attributes	Lead Acid	Li-ion	Natron
Fire due to heat	●	●	●
Fire due to mechanical damage	●	●	●
Fire due to electrical faults	●	●	●
No Acid	●	●	●
No Heavy Metals	●	●	●

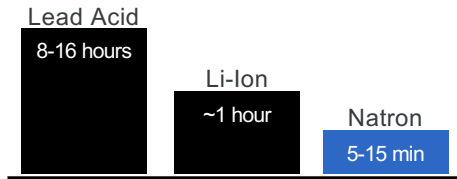
# Natron – More Power, More Often, Faster, Longer

## High Power / Small Footprint

Discharge Power Density

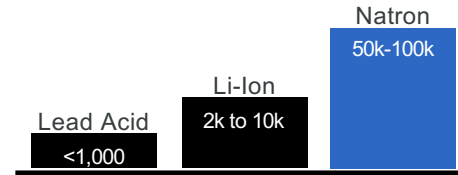


Recharge Time



## Reliable

Cycle Life



Calendar Life



# Safety



# The Safest Battery Ever Built

- No fire or explosion after puncture, pressure, heat, or electrical faults
- We are the only battery manufacturer to publish our unredacted UL test report

## Nail penetration test

Natron



Li-ion



## High speed projectile test

Natron



Li-ion



Safety video: <https://youtu.be/vvcvg7xGo1U>



Safe for Air  
Transport

# So Safe It Can Be Transported Fully Charged

- Not considered hazardous goods
- Can be shipped installed in a battery cabinet
- Can be shipped by ground or air **fully charged**



**Not needed  
for Natron  
batteries!**



*According to the International Air Transport Association, "...lithium-ion cells and batteries shipped by themselves must be shipped at a state of charge not exceeding 30% of their rated capacity. Lithium batteries are dangerous goods, and all of the regulatory requirements must be complied with..."*





# What Are The Risks of Competing Technologies?

Safe

No Fire Hazard



Electric Buses Pulled by  
CTtransit



IATA Calls for Lithium  
Battery Transportation  
Standards



Tesla Model S Catches Fire  
While Charging

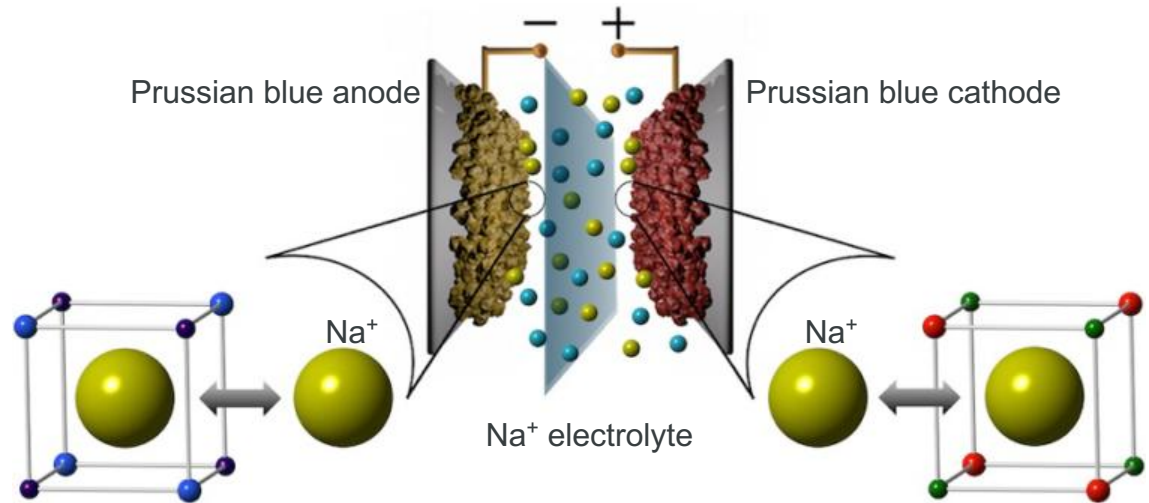
Natron Safety Web Page: <https://natron.energy/battery-safety/>

# Technology



# Natron's Platform: A Unique Sodium-Ion Battery Cell

- Prussian blue pigment electrodes store sodium ions
  - Unique atomic structure for faster charge/discharge and 10x longer cycle life
- Nonflammable
- No mineral constraints
- No hazards that limit safe end-of-life disposal
- Drop-in to industry-standard manufacturing lines

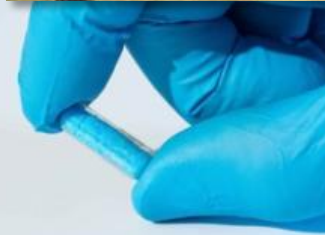


# What is Prussian Blue?

The name Prussian blue originated in the 18th century, when the compound was used to dye the uniform coats for the Prussian army. It has been used for centuries in unusually diverse applications. Despite the presence of cyanide groups, the pigment is not toxic to humans.

## Uses for Prussian Blue

- Paints, inks, and enamels
- Textiles, rubber, and plastics
- Antidote for heavy-metal poisoning
- Histopathology stain for detecting iron
- Blueprints
- Typewriter ribbons and carbon paper (now obsolete of course!)



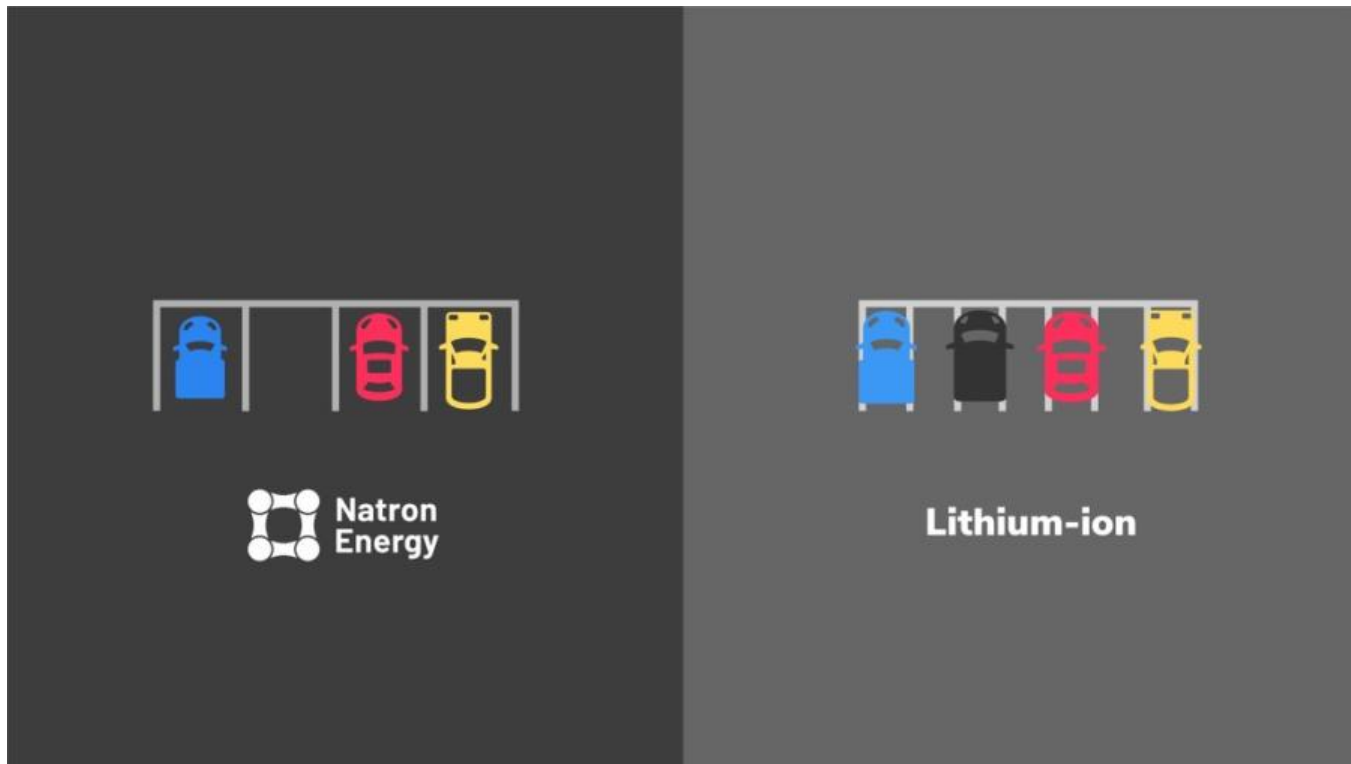
An interesting history of Prussian Blue can be found at [https://en.wikipedia.org/wiki/Prussian\\_blue](https://en.wikipedia.org/wiki/Prussian_blue)

# All About the Blue

- Very low internal resistance
  - Same reason for our safety advantage
- 70% of rated energy is delivered during 2 minute discharge
- Extremely rapid recharge
  - 0-99% SOC in <15 minutes
  - Available immediately - no settling required



# Cars In Parking Spaces?



*Natron sodium ions are smaller than the Prussian Blue structures which hold them, making thermal runaway impossible.*



# Rapid Discharge/Charge Cycle

- Half the internal resistance per energy of lead acid
- Significantly greater percentage of total energy delivered during rapid discharge
- 70% of rated energy is delivered during 2-minute discharge
- 33% of rated energy is delivered during 30 second discharge
- Extremely rapid recharge with no settling required
  - 0-99% SOC in <15 minutes
  - 0-70% SOC during 16C recharge lasting 2.5 minutes
  - 70-99% SOC during constant voltage hold lasting 6 minutes
- Natron delivers more power, more often, faster than any other chemistry

# Extremely Wide Temperature Operating Range

- Operating Range 0 to 45°C / 32 to 113°F
  - - 50°C to + 50°C consult factory
- Rated Transportation Range -20 to 45°C / -4 to 113°F
- Nominal Range 10 to 20°C / 50 to 68°F





# We stand tall on TCO!

No other battery technology  
can match our Total Cost of  
Operations



# Environmental, Social, and Governance

The Strongest ESG  
Responsible Battery Solution!



# Cleaner and more sustainable than the incumbents

Natron eliminates the “blood” minerals

- No lithium, cobalt, nickel, copper

Natron eliminates lead, the source of a global public health crisis

- Uncontrolled emissions from lead smelting and recycling

Longer life and safer disposal

- Up to 3x longer operating life in a data center
- Disposal as universal waste at any general waste processing site

Cobalt mining, Congo



Lead acid recycling, Indonesia



# Various Media Agree on Questionably Sourced Minerals

www.natron.org

**icct**  
THE INSTITUTE FOR CLEAN TECHNOLOGY

BRIEFING

FEBRUARY 2018

Effects of battery manufacturing on electric vehicle life-cycle greenhouse gas emissions

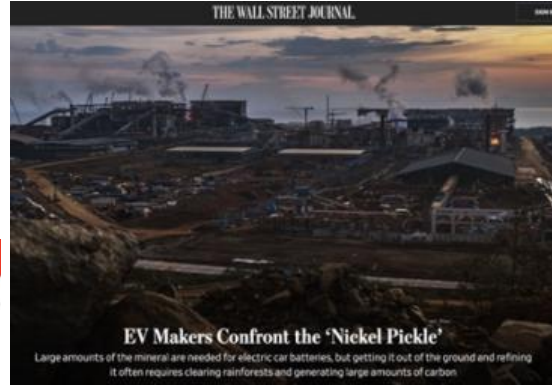
IP

ANALYSIS **Green Energy's Dirty Secret: Its Hunger for African Resources** | [View Comments \(7\)](#)

## Green Energy's Dirty Secret: Its Hunger for African Resources

The scramble for battery metals threatens to replicate one of the most destructive dynamics in global economic history.

By **Colas van Staden**, the managing editor of the China Global South Project.



**EV Makers Confront the 'Nickel Pickle'**  
Large amounts of the mineral are needed for electric car batteries, but getting it out of the ground and refining it often requires clearing rainforests and generating large amounts of carbon.

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### Technology

## Blood minerals are electronics industry's dirty secret


A crackdown in the US is forcing technology firms to come clean about the source of the minerals used in their smartphones and electronics

By Paul Marks

11 June 2014

**IndustryWeek** INDUSTRY WEEKLY

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**Lithium Batteries' Dirty Secret: Manufacturing Them Leaves Massive Carbon Footprint**

Oct. 10, 2018

Clear its reputation, electric cars verbally reduce your carbon footprint, but making the batteries and batteries could emit 1/3 more CO2 than for conventional cars.

**npr** **WETS89.5** [SIGN IN](#) [NPR SHOP](#)

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GOATS AND SODA

## How 'modern-day slavery' in the Congo powers the rechargeable battery economy

February 1, 2023 - 12:38 PM ET  
Heard on Fresh Air

[Terry Gross](#)

**36-Minute Listen** [+ PLAYLIST](#) [SHARE](#) [CLOSE](#)

A photograph of a person in a dry, dusty environment carrying a large, heavy sack on their shoulder. The person is wearing a light-colored shirt and appears to be walking towards the camera. The background shows a hilly, arid landscape.

# Compare To Positive Press Surrounding Natron Energy

MIT Technology Review

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CLIMATE CHANGE

## This abundant material could unlock cheaper batteries for EVs

Sodium-based batteries could start hitting the market this year, if companies follow through on their plans.

By Casey Crownhart May 9, 2023

Scaling Up: Advancing Battery Technology from the Lab to the Market with Na

Watch later



Dr. Daniel Cunningham  
TECHNOLOGY-TO-MARKET ADVISOR, ARPA-E

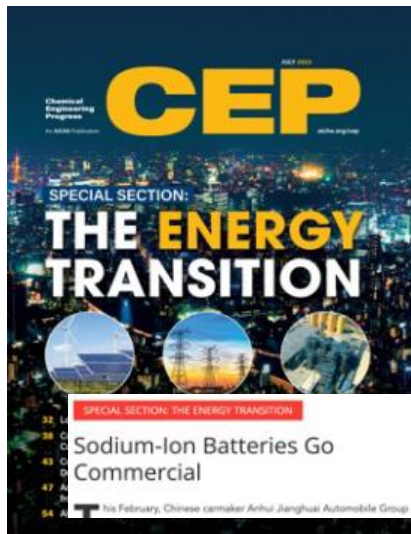
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Chemical Engineering Progress

# CEP

JULY 2023

SPECIAL SECTION: THE ENERGY TRANSITION



SPECIAL SECTION: THE ENERGY TRANSITION

## Sodium-Ion Batteries Go Commercial

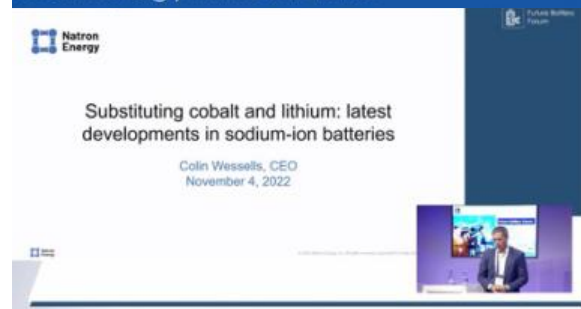
July 2023 February, Chinese carmaker Anhui Jangshui Automobile Group

## Future Battery Forum 2022, Battery technology innovations

Natron Energy

### Substituting cobalt and lithium: latest developments in sodium-ion batteries

Colin Wessells, CEO  
November 4, 2022



write to

## NZZ magazin

1 result

Anytime

### The blue miracle of energy: from the conquest of sodium-ion batteries

Lithium-ion batteries still dominate the world market. But now there is a new technology that does not require expensive and ecologically sensitive raw materials.

Andrew Hirston



# Supply Chain





# No Supply Chain Constraints!

## Secure Supply Chain

Natron does not depend on questionable supply chains

- No impact from geopolitical events

Natron can source from multiple supply chains if ever needed

- No constrained resources to jeopardize our manufacturing
- We use raw materials that have stable pricing



*These are not  
an issue for  
Natron!*



# Products





# Blue Tray 4000 - Rack Mounted Battery Tray

- UL 1973 Listed
- UL 9540A testing completed
  - (database <https://bit.ly/3iib9lv>)
- Double the 2-minute power of lead acid
- Over a dozen successful customer demonstrations
- Several leading telecom and data center end customers
- Compatible with UPSs with a 48VDC battery input
- Collaborating on product integration with OEMs
  - Xtreme Power P91 2, 3, & 5kW version UPSs
  - ABB rectifiers
  - CE+T UPS / Inverters
  - Benning rectifiers
  - Schneider Electric
  - Vertiv...soon

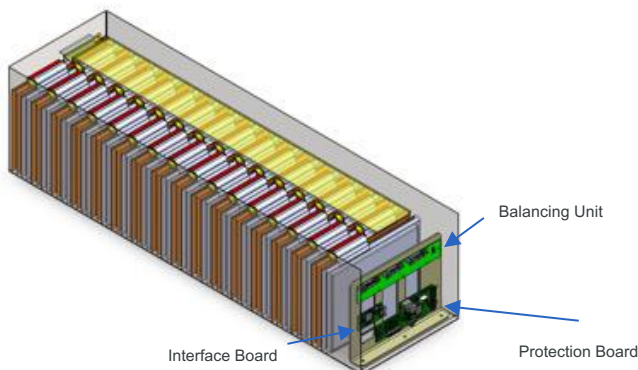


Performance Spec	Natron BlueTray 4000	Lead Acid
Mechanical	1U height, fits 19" rack 600mm depth	1U height, fits 19" rack 600mm depth
Electrical	50V nominal (58 – 32V)	48V nominal (54.5 – 38V)
Power, run time	6 kW, 1 min > 4 kW, 2 min	3 kW, 2 min
Service life	5-7 years expected 3 years warranty	2.5 years expected 1 year warranty
Cycle life	>10,000 cycles warrantied	<100 cycles
0-99% recharge time	<10 minutes	12-24 hours
Safety	Nonflammable – UL9540A No heavy metals	Lead, acid



# BluePack 25kW Battery

- Availability late 2023 prototypes, to early 2024 production
- Modular 25kW, 48V packs can be serialized for power systems from 96 to 812Vdc
- Operating Voltage range of 58 to 32 volts for max power/energy delivery
- 800 Amp discharge & charge capable
- Class-leading charge and discharge



Watch it being tested here: [https://www.youtube.com/watch?v=a3GURWZs\\_ec](https://www.youtube.com/watch?v=a3GURWZs_ec)

# Batteries

**Natron Energy**

Blue Rack Sodium-Ion Battery Cabinet BR-250



Blue Rack is the first sodium-ion battery cabinet designed for mission critical applications, such as data centers, peak power shaving, and other industrial power environments where a reliable backup power source is required to ensure 100% uptime.

*Image courtesy of Natron Energy*



# Critical Power Battery Cabinets Launching Late 2023

- High Peak Power capacity eliminates need for N+1
- Higher power cabinets enable 2+ MVA UPS power blocks
  - Fewer strings
  - Higher per cabinet standard power
  - Significantly higher Peak Power capacity
- 250 kW per cabinet nominal at a 2-minute discharge
- 340 kW+ peak at <1 minute discharge rating
  
- Can be combined to make larger systems



# Industrial Power Battery Cabinets Launching Late 2023

- High Peak Power capacity eliminates need for N+1
- Higher power cabinets enable 2+ MVA UPS power blocks
  - Fewer strings
  - Higher per cabinet standard power
  - Significantly higher Peak Power capacity
- 672VDC nominal & 812VDC Peak
- 350 kW per cabinet nominal at a 2-minute discharge
- 560 kW+ peak at <1 minute discharge rating
  
- Can be combined to make larger systems



# Applications And Use Cases



# Single or 3-Phase UPS or In-Rack Power

- OEM battery option for ABB Edge cabinet
- OEM battery for outdoor, uncooled installation
- OEM battery option for Single Phase UPS
- Being integrated by “big name” 3-Phase UPS manufacturers

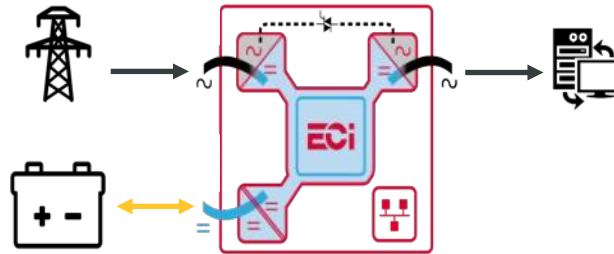


# Energy Injection / Peak- Power / Demand Response

- Enabling Software Defined Power
- Localized energy storage, peak power capping / augmenting
- Extending life of current UPS / power infrastructure



4 – 20 kW power block



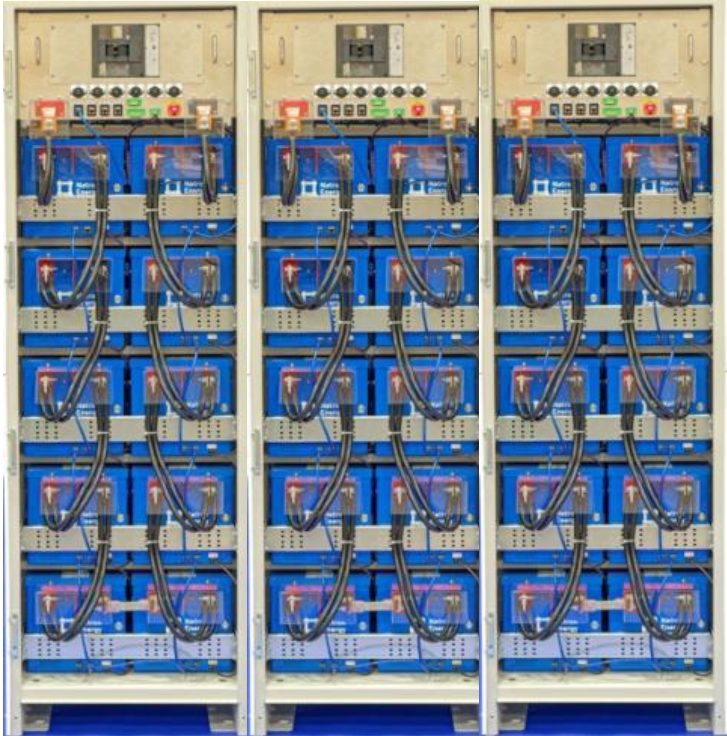
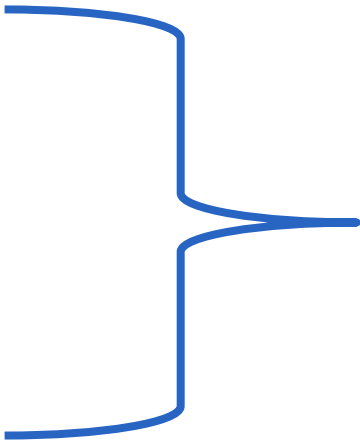
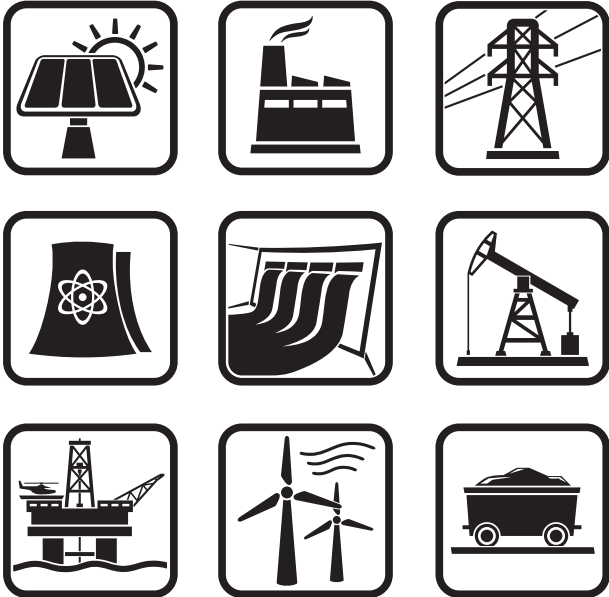
MW+ multi-mode Power /  
Energy system



10 – 80 kW power rack



# Micro-Grid and Grid Stabilization



# Dark Start

High Power for  
Engine/Turbine  
Starting systems

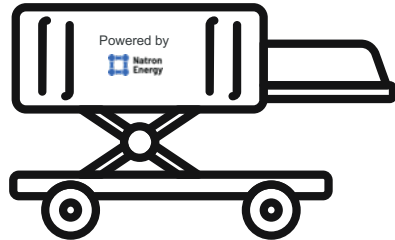
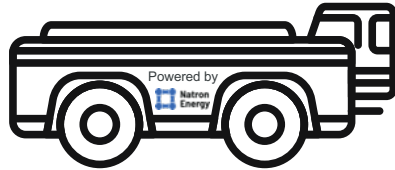


# Phase Correction & Power Factor Correction

- Variable Frequency Drives
- DC Power Systems
- Process Plants
- Chemical Plants
- Petrochemical Facilities



# Airlines and Ground Support Equipment

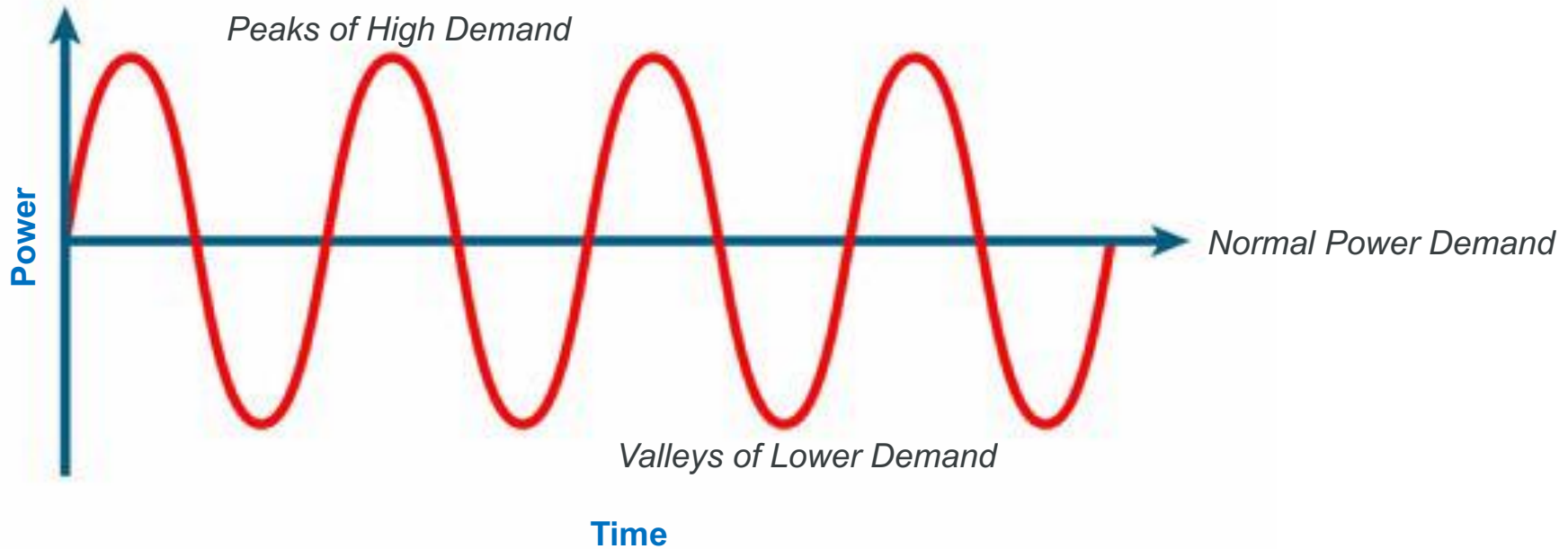


United Airlines is an investor in Natron Energy

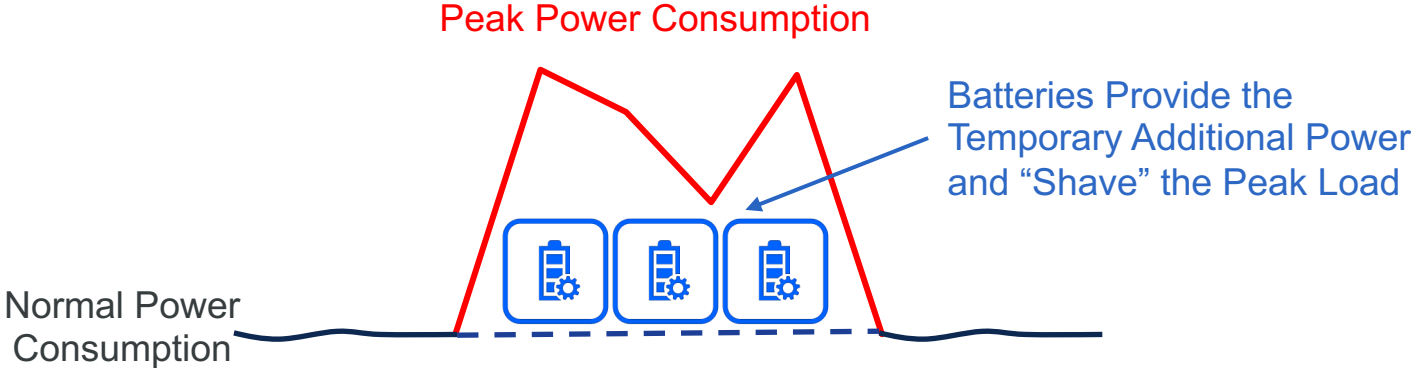
# We Can Help With Decarbonization!



# Peak Loads – What are They?



# Peak Load Shaving with ESS Basic Concepts



# Application: Hybrid Engine/Generator & Industrial De-Carbonization Use Case #1

- Batteries used as peak shaving for drill rig power system, displacing a generator
- Diesel fuel savings business model
- Hundreds of sites globally
- Tried other storage systems first - FAILED
- Managing peak loads from seconds to 15 minutes
- Natron solution requires no maintenance
- Cycle life very appealing – can be hundreds of partial discharges per day
- Best TCO & lowest OPEX battery system available





# Application: Hybrid Engine/Generator & Industrial De-Carbonization Use Case #2

- Hybrid system like Use Case #1, but adds dark start
- Fuel & CO2 optimized micro-grid environments
- Supplemental utility grid providers
- Remote sites – mobile generation/grid supplement
- Functions as part of a hybrid BESS as well



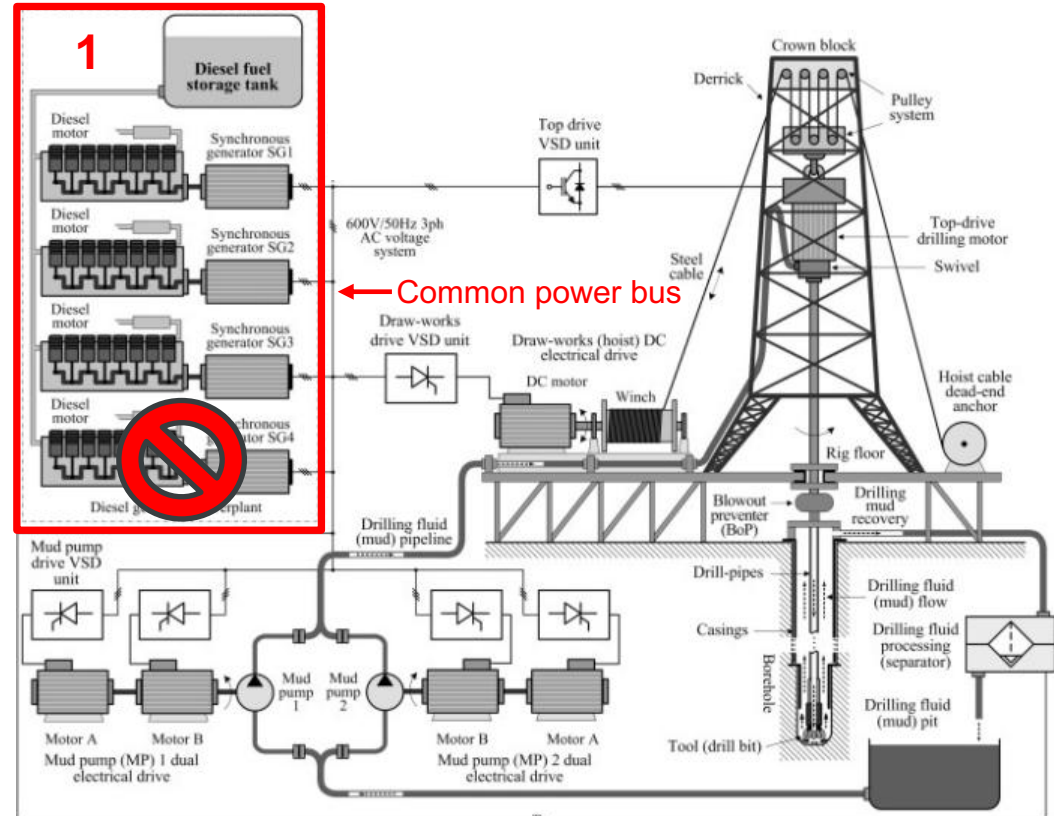
# Typical Oil Rig Power System

1 – Diesel generators working in parallel

2 – Battery Energy Storage System (BESS) displaces one generator

## Results:

- Fuel Savings >20%
- CO<sub>2</sub> Reduction >30%
- ROI <2 Years



# Manufacturing Status



# First Mass Manufacturing Q4 2023

- Santa Clara pilot line currently delivering Blue Trays and Blue Packs
- Partners secured and plant upgrades underway for 2023 high volume launch



- 6-year supply agreement to produce Prussian blues for Natron
- World class fine chemicals manufacturer
- No competitive battery businesses

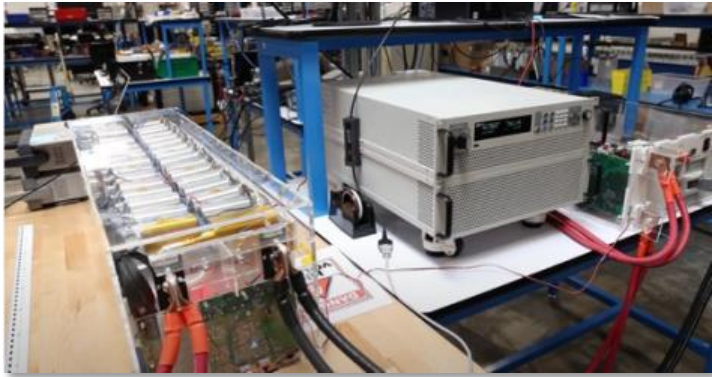
- Natron has a 6-year lease to operate an existing Li-ion plant owned by Clarios to manufacture electrodes and cells
- Access and use >\$100M existing plant capex
- Supported by a \$20M grant from ARPA-E for new capex

- Tier-1 electronics assembly CM



# Office & Factory Tours and Demos Available Now

- **Santa Clara, CA Operations and Lab / Demo test facilities**
  - Bring us your load profile and use case
  - Coordinate with sales team for on-site test and validation
  - Design your battery system in real-time
  - Order and schedule your initial test and development units / systems



Watch it being tested here: [https://www.youtube.com/watch?v=a3GURWZs\\_ec](https://www.youtube.com/watch?v=a3GURWZs_ec)

# Your Natron Support Team



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## Additional links

### ▪ SAFETY:

- Safety Video - <https://youtu.be/vvcvg7xGo1U>
- UL Listing press release <https://bwnnews.pr/3mO90I2>
- Cell cutting video: [https://youtu.be/qsj\\_Yakpv60](https://youtu.be/qsj_Yakpv60)

### ▪ ARPA FUNDING:

- DOE ARPA-E 2020 Initial \$20M grant <https://bit.ly/2FA41Kp>
- ARPA-E 2022 Scale Up Award video <https://youtu.be/AxMag8zXEtY>
- ARPA-E 2022 Energy Innovation Summit video <https://youtu.be/QiC-woOFBRU>

### ▪ APPLICATIONS:

- Mission Critical – Software Defined Power <https://bit.ly/3cMif9E>
- Blue Rack Battery Cabinet PR [https://natron.energy/wp-content/uploads/Natron\\_BlueRack500PR\\_10-11-22-FINAL.pdf](https://natron.energy/wp-content/uploads/Natron_BlueRack500PR_10-11-22-FINAL.pdf)

### ▪ PERFORMANCE

- **Test Video:** <https://natron.wiki/3SnnkWT>

### ▪ GROWTH/INVESTMENT/MARKETS:

- Michigan Factory PR [https://natron.energy/wp-content/uploads/natron\\_collateral\\_clarios\\_press\\_release\\_050422.pdf](https://natron.energy/wp-content/uploads/natron_collateral_clarios_press_release_050422.pdf)
- United Airlines investment PR <https://natron.energy/wp-content/uploads/Natron-United-Joint-Release-final.pdf>
- VAST Solar LOI PR [https://natron.energy/wp-content/uploads/Natron\\_Vast-Solar-press-release\\_FINAL\\_logos.pdf](https://natron.energy/wp-content/uploads/Natron_Vast-Solar-press-release_FINAL_logos.pdf)
- Mercuria investment PR [https://natron.energy/wp-content/uploads/Natron\\_Mercuria-press-release\\_FINAL-2022.pdf](https://natron.energy/wp-content/uploads/Natron_Mercuria-press-release_FINAL-2022.pdf)
- Arxada Supply Agreement PR <https://natron.energy/wp-content/uploads/221018-Arxada-Natron-starting-large-scale-production-in-Visp-FINAL9.pdf>
- Liberty Energy investment PR <https://www.businesswire.com/news/home/20220903005025/en/Liberty-Announces-Investment-in-Natron-Energy>
- Nabors Energy investment PR [https://natron.energy/wp-content/uploads/07212022\\_Nabors\\_Natron-Energy-FINAL.pdf](https://natron.energy/wp-content/uploads/07212022_Nabors_Natron-Energy-FINAL.pdf)

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