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August 24-27, 2020

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informa tech

Energy Storage Technology Trends – Implications for Mission Critical Infrastructure

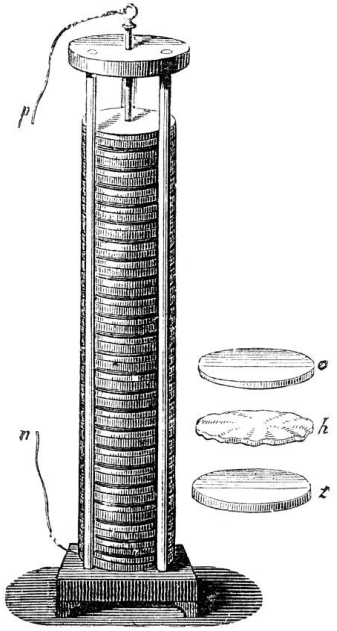
Jack Pouchet

VP Sales

Natron Energy

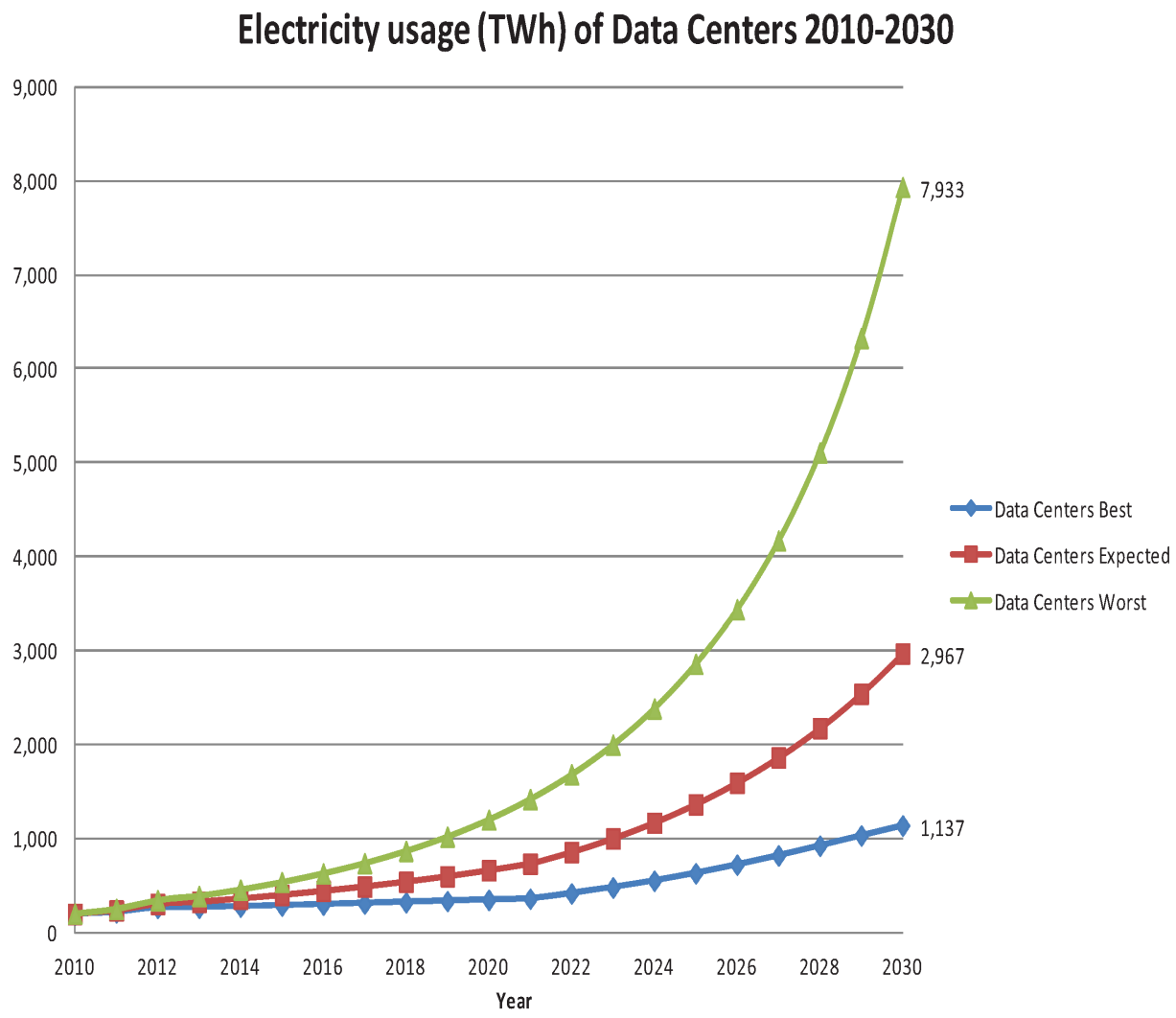
Volta – 220 Years Later

- Data Center energy consumption – driving / forcing new power systems
- Regional / Local energy production: all about renewables
- Regional / Local energy production: all about renewables
- The more things change….
- Grid Energy Storage – full of exciting announcements



Data Center Electrical Energy Consumption – There is an Upper Limit

- 416 Terra Watts[1]
  - 3% Global Electrical Generation
- Cloud Computing alone uses more electricity than all of Japan
- 277 Terra Watts (estimate)[2]
  - Data Communications, Networks, Subsea Cables, Wireless
- Edge? Double Counting?
- HyperScale Data Centers exceed 500[3]

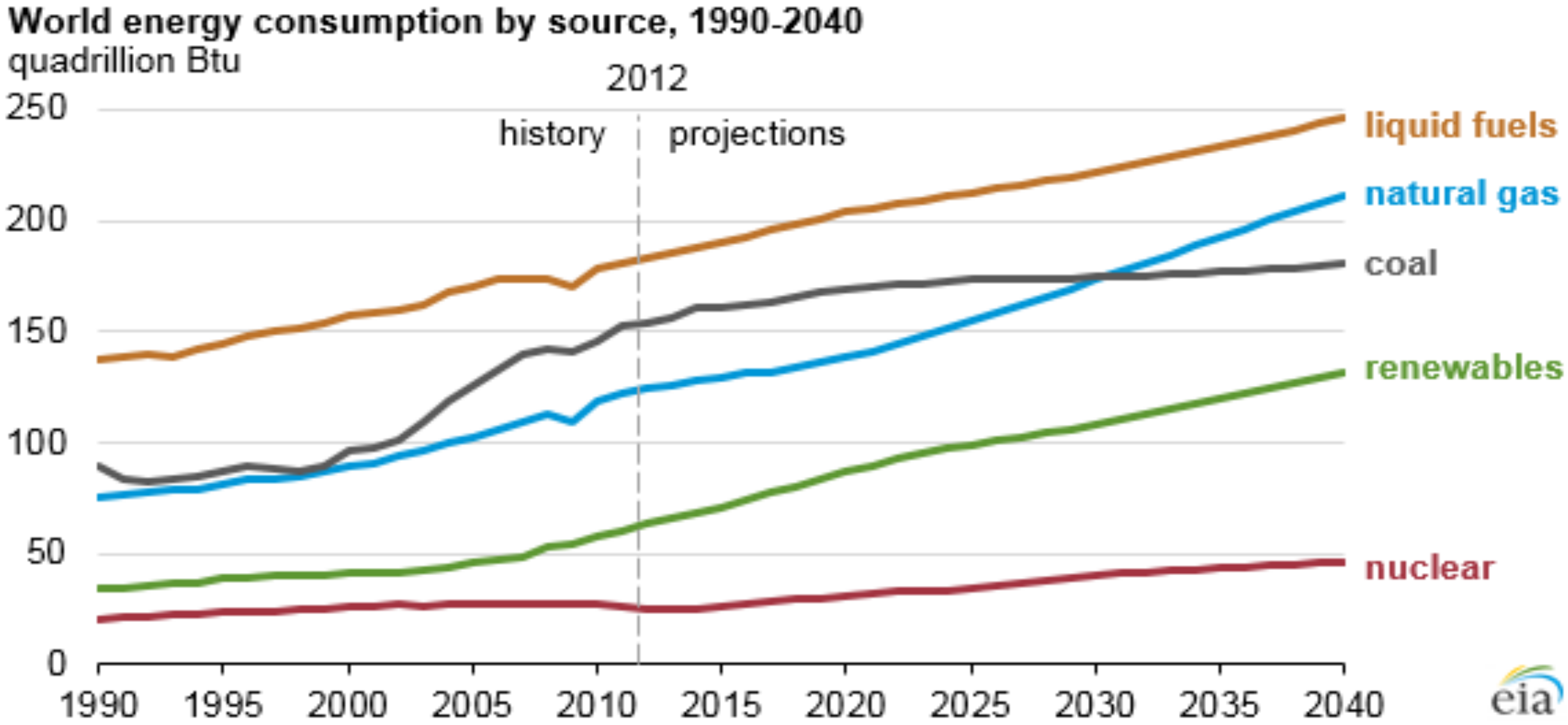


1 https://data-economy.com/the-importance-of-green-data-centres/

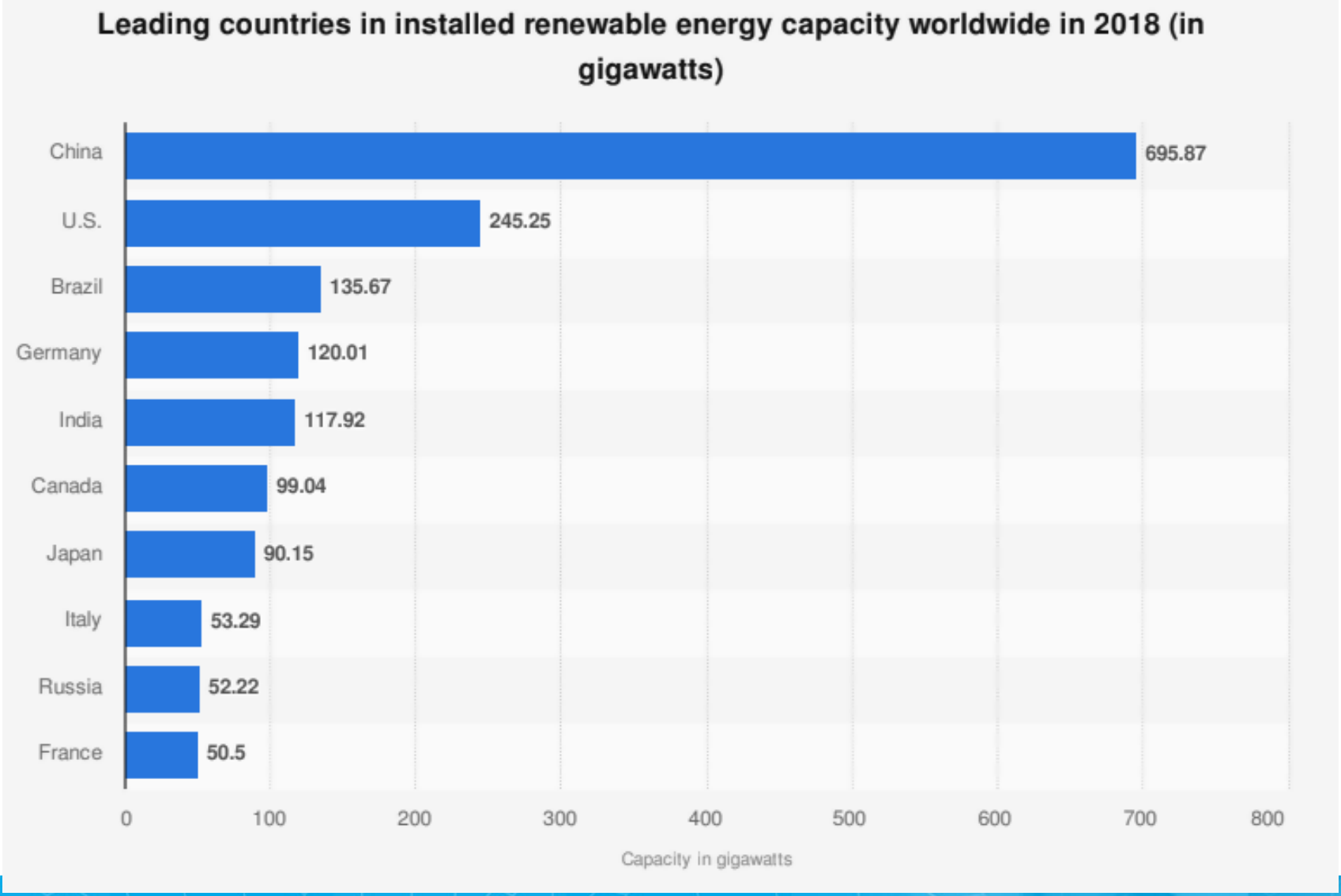
2 https://www.hindawi.com/journals/jcnc/2013/897029/

3 https://www.srgresearch.com/articles/hyperscale-data-center-count-passed-500-milestone-q3

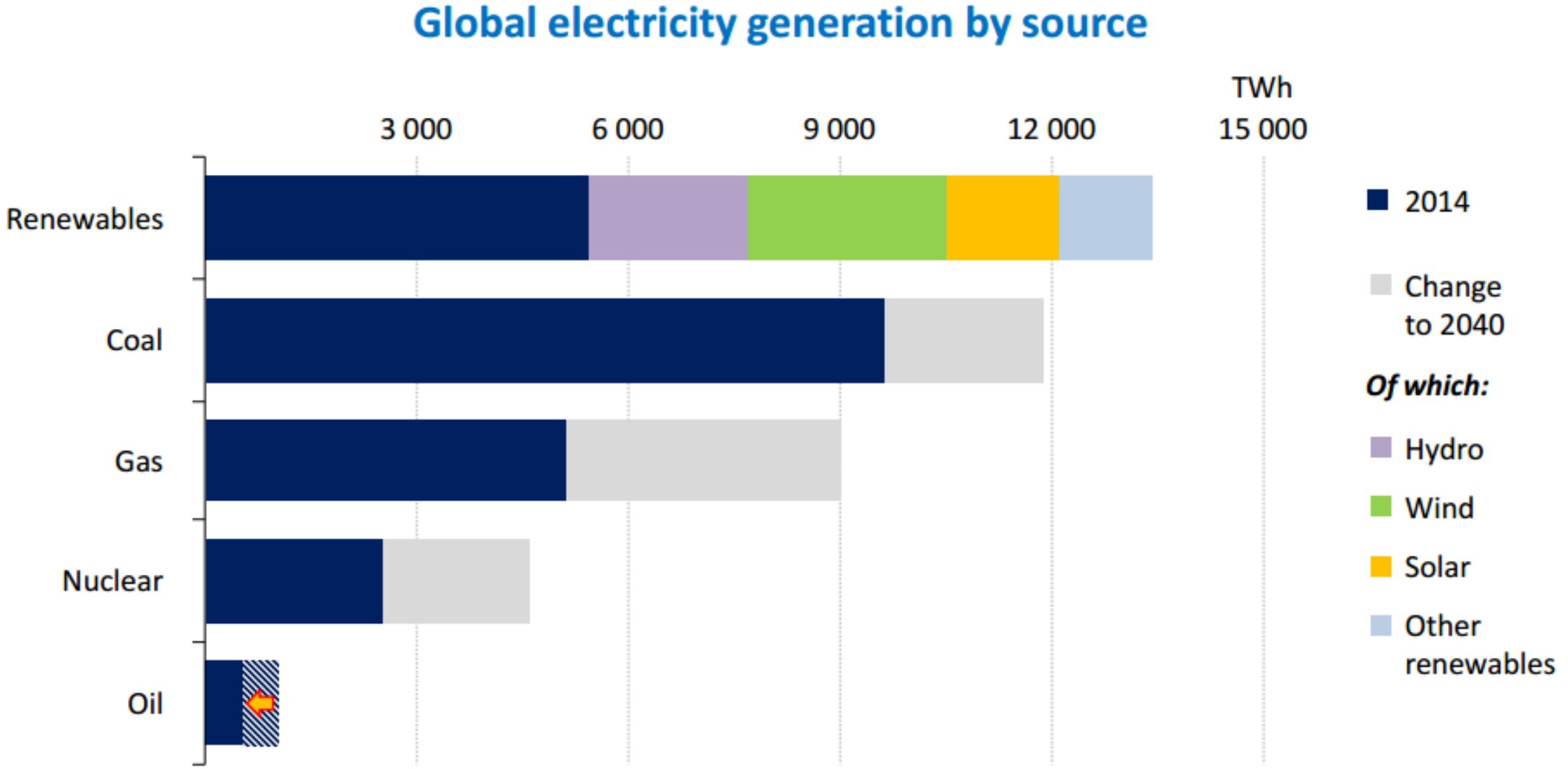
Energy Use – All Types, Applications



Exponential Growth of Renewables – Not Likely

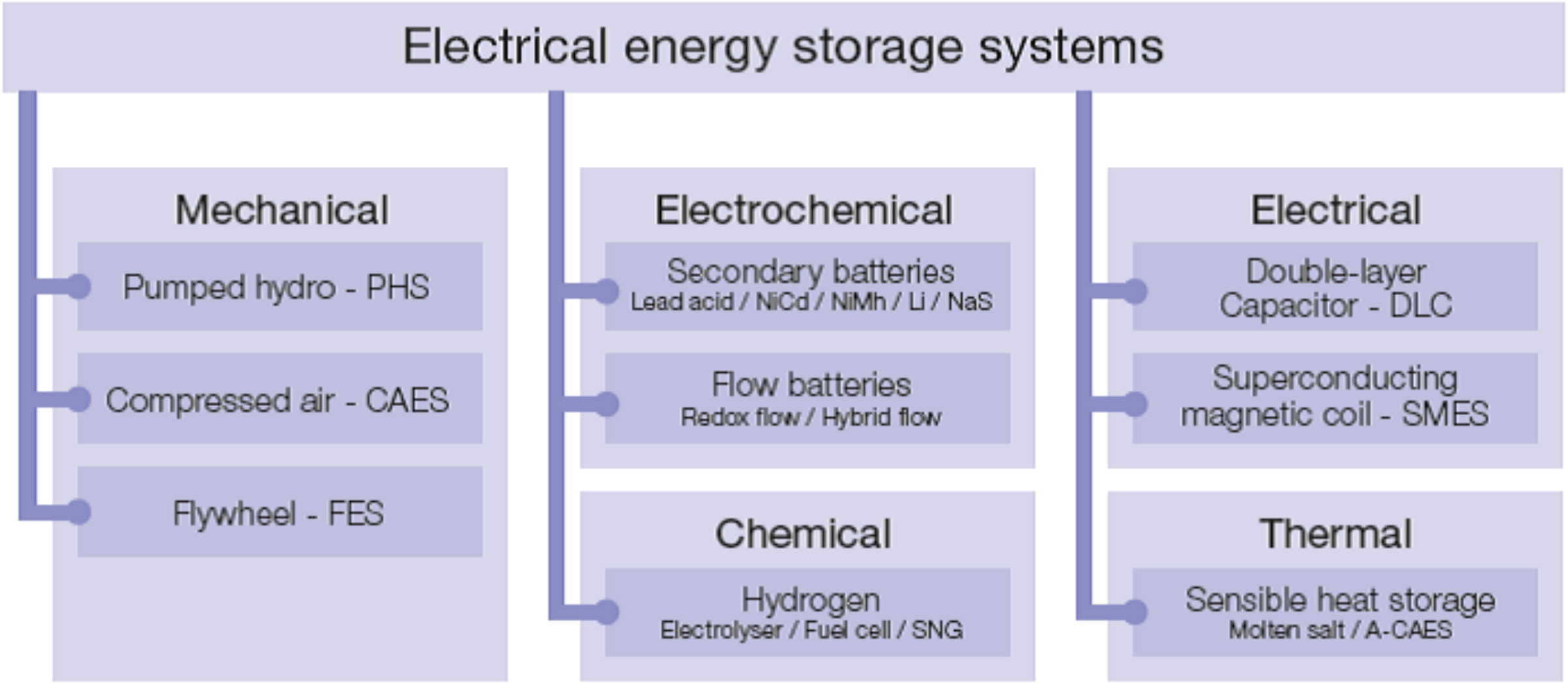


Electricity – Best Chance at a Green Future



Driven by continued policy support, renewables account for half of additional global generation, overtaking coal around 2030 to become the largest power source

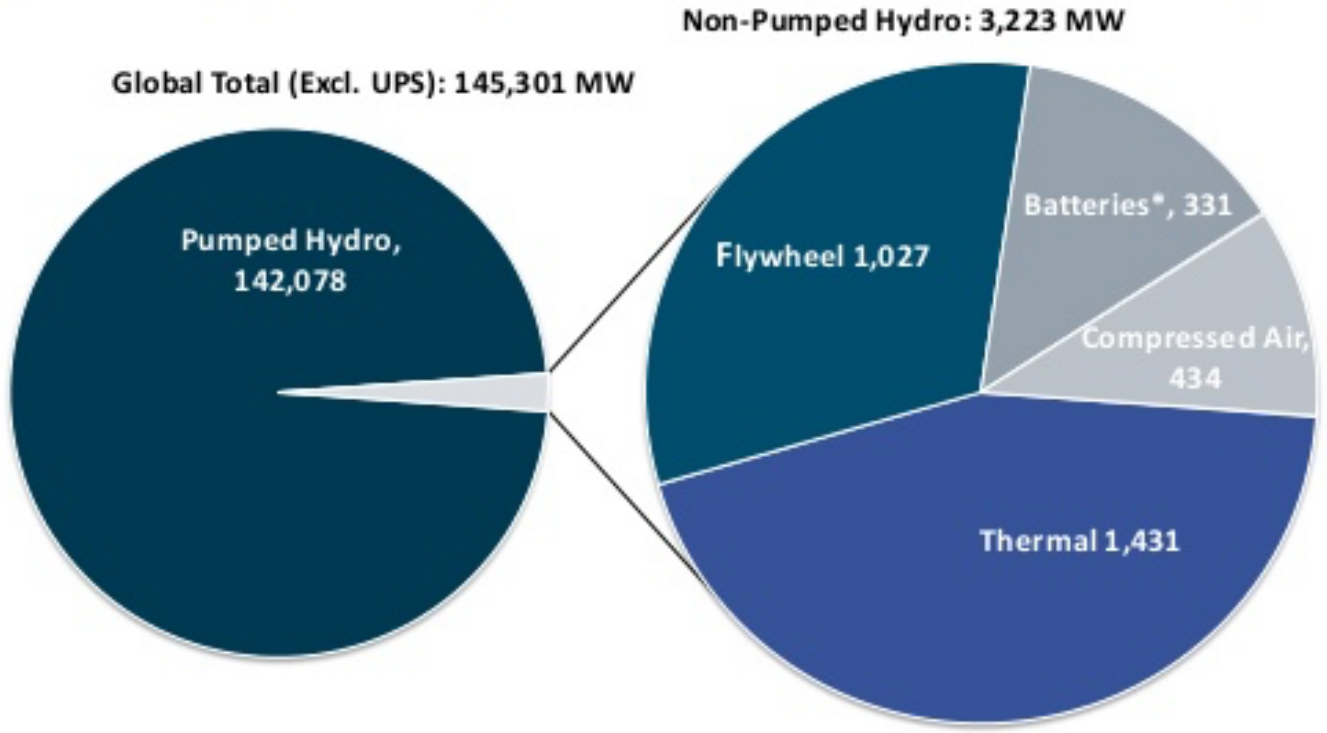
Grid Stability / Availability Require Storage



Hydro Rules!

Projects: 145 GW installed - 50 Technologies Represented

Estimated Global Installed Capacity of Energy Storage (MW)
Represents approximately 2.7% of Global Installed Electric Capacity[1]



Source: Based on DOE Global Energy Storage Database (http://www.energystorageexchange.org) Est are current as of January 2014

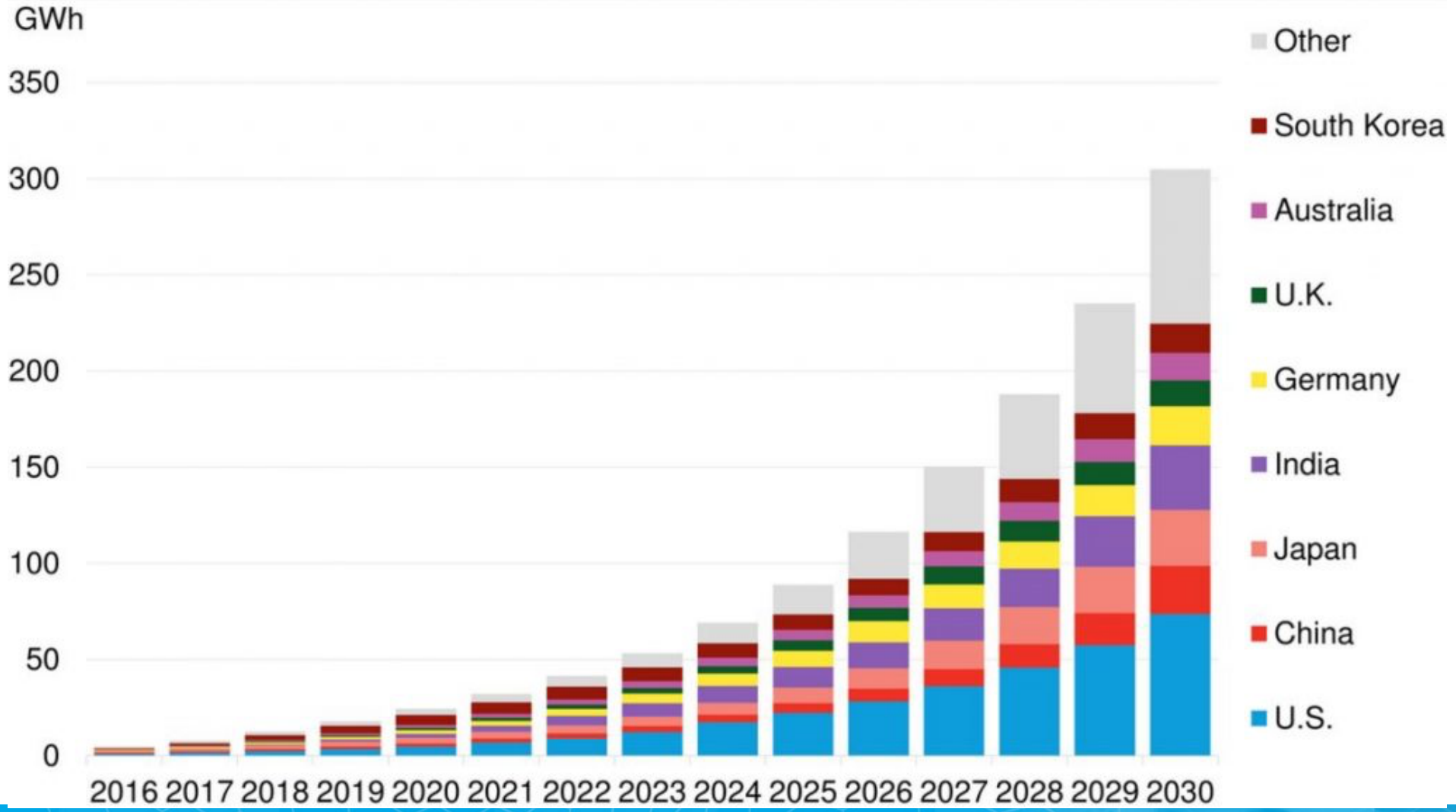
[1]Based on EIA 2010 Total Electricity Installed Capacity Data (http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=2&pid=2&aid=7)

* Batteries include Flow, Lithium Ion, Sodium Sulfur, Nickel Cadmium, Lead Acid, and Ultra Batteries

Note:
Excludes UPS / Data Centers
3-Phase / MW sites
1.1 – 1.3 Capacity
Batteries (Lead)
Generators (Diesel)

CESA
CALIFORNIA ENERGY STORAGE ALLIANCE

Projected Growth of Global Electrical Energy Storage



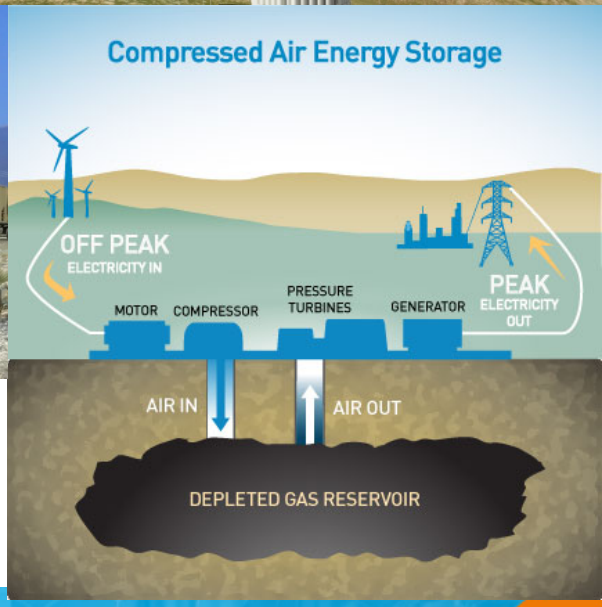
>75% Hydro

New Systems / Technologies Emerging

- Internal, On-site, Near-site, Grid

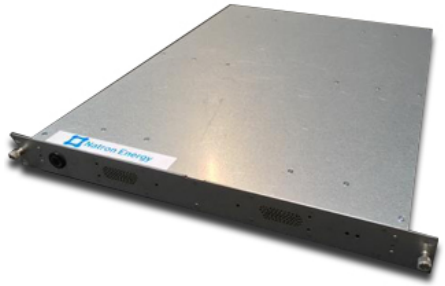
- Old, New, Emerging Platforms
  - Batteries
  - Flywheels / Capacitors
  - Pumped Hydro/ Compressed Gas
  - Thermal
  - Gravity

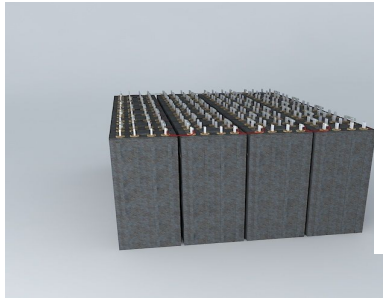
- Power, Energy, Volume, Acceleration
  - All Now
  - Some for a While
  - Months / Years
  - Opps, more than you imagined before you knew it

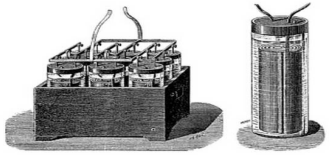


Batteries: Still the Most Practical

Cycles







Density

Introduction to Natron Energy

- Company:
  - Founded in 2012 as a Stanford spin out.
  - > $70 M raised to date, from investors including ABB, Chevron, Khosla Ventures, and Prelude Ventures.
  - Won two ARPA-E grants totaling $4.6M (3% acceptance rate).
  - 50+ employees based in Santa Clara, CA.

- Product:
  - High power, long life, safe, rack mounted battery packs.
  - New cell chemistry: Prussian blue electrodes / sodium-ion electrolyte.

- Status:
  - Customer validation in Data Center markets complete, transitioning to cc
  - UL Certification to UL9540A (Nonflammable, no thermal runaway) NFPA8
  - UL1973 Listed battery
  - January 2020 pre-production,
  - Shipping UL Listed units now
  - Software Defined Power Platform shipping now
  - Large Battery Cabinet (300kW) – POC Q3 2021

NOTICE OF COMPLETION
AND
AUTHORIZATION TO APPLY THE UL MARK

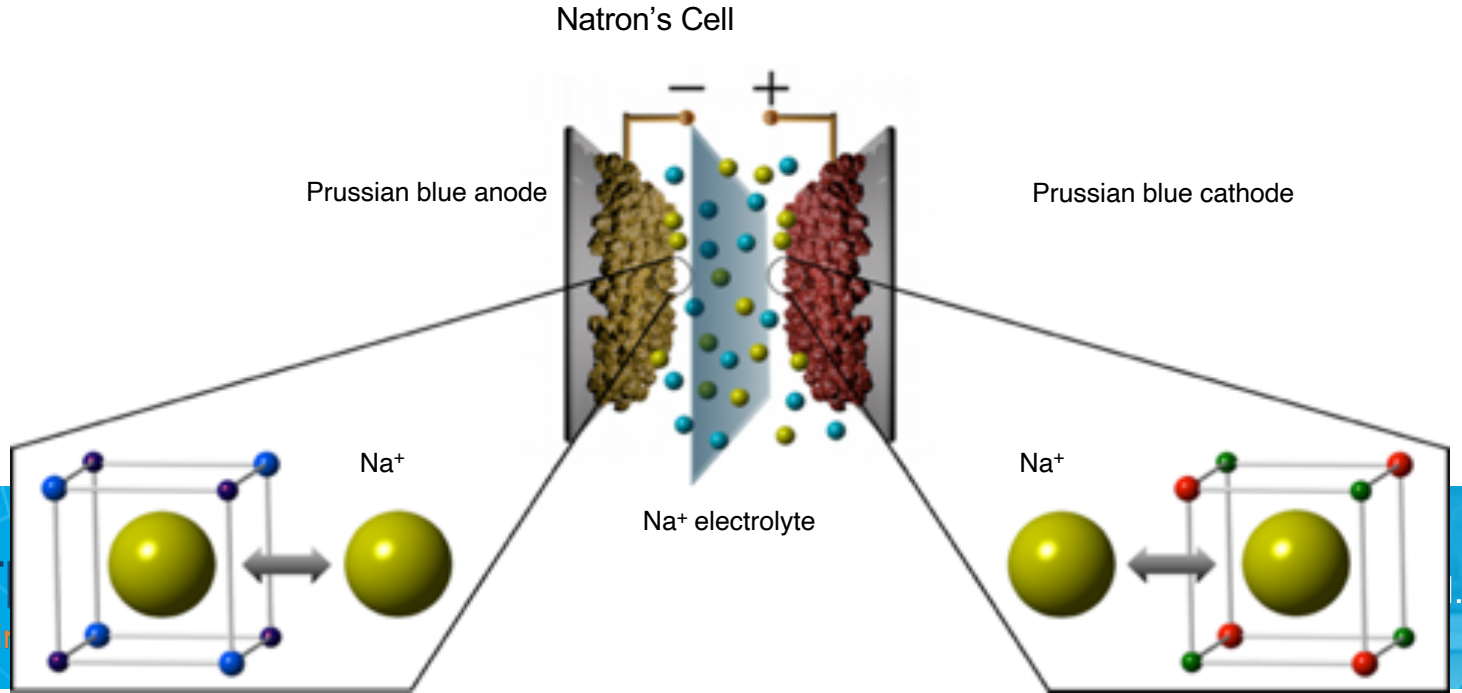
2020-07-31

Mr. Vinay Panchal
Natron Energy, Inc.
3542 Bassett Street
Santa Clara, CA, 95054, US

Our Reference:	File MH63828, Vol 1	Order:	12927524
		Project:	4789070555
Project Scope:	UL 1973 Listing Evaluation of Sodium-ion Battery System, Model Blue Tray 4000, rated 58 V, 4.6 Ah		

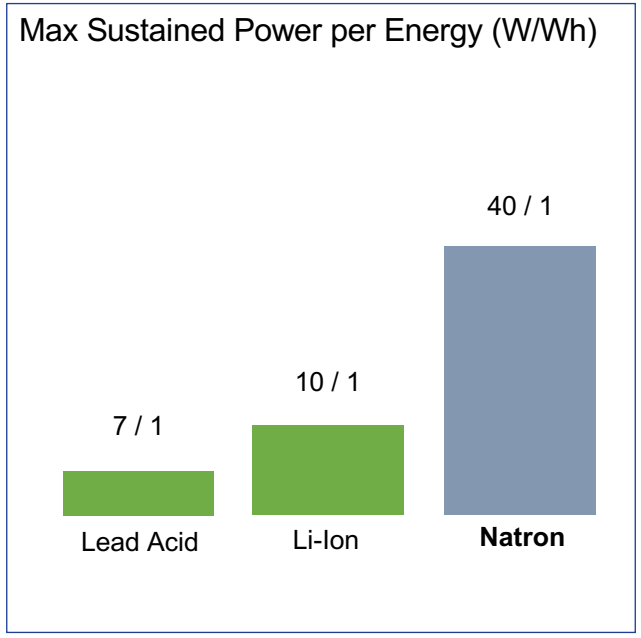
Unique Prussian Blue Battery Cell

- Prussian blue pigment electrodes store sodium ions.
- Zero-strain charge storage for 10x faster cycling and longer life.
- Extremely low internal impedance.
- No Rare Earth metals or giant holes in the ground.
- Drop-in to existing pigment plants and Li-ion manufacturing lines.

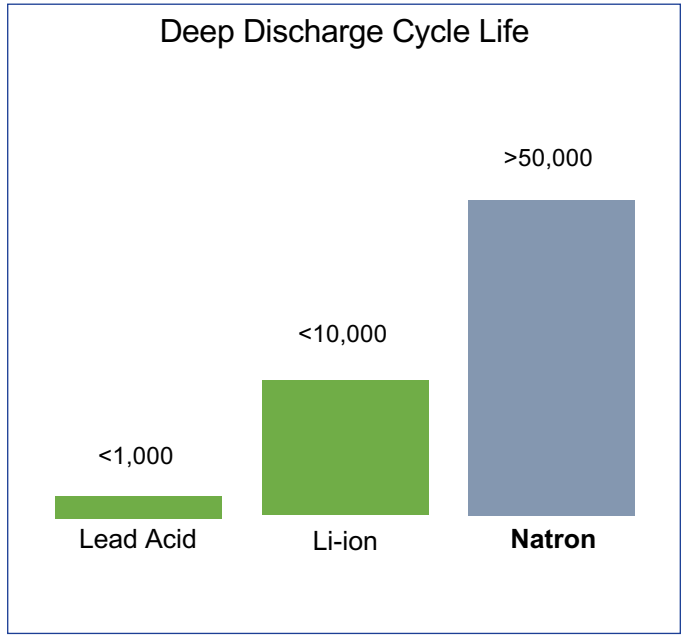


A High Power, Long Life, Safe Battery

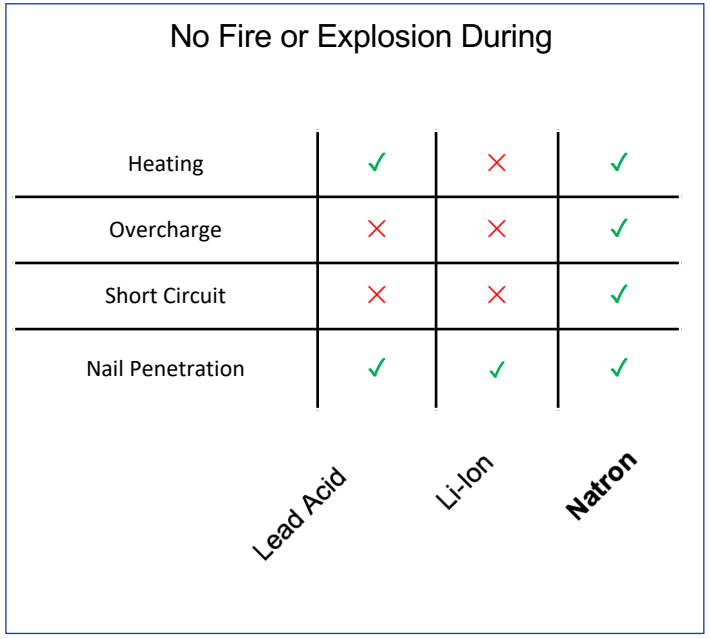
High Power



Long Life

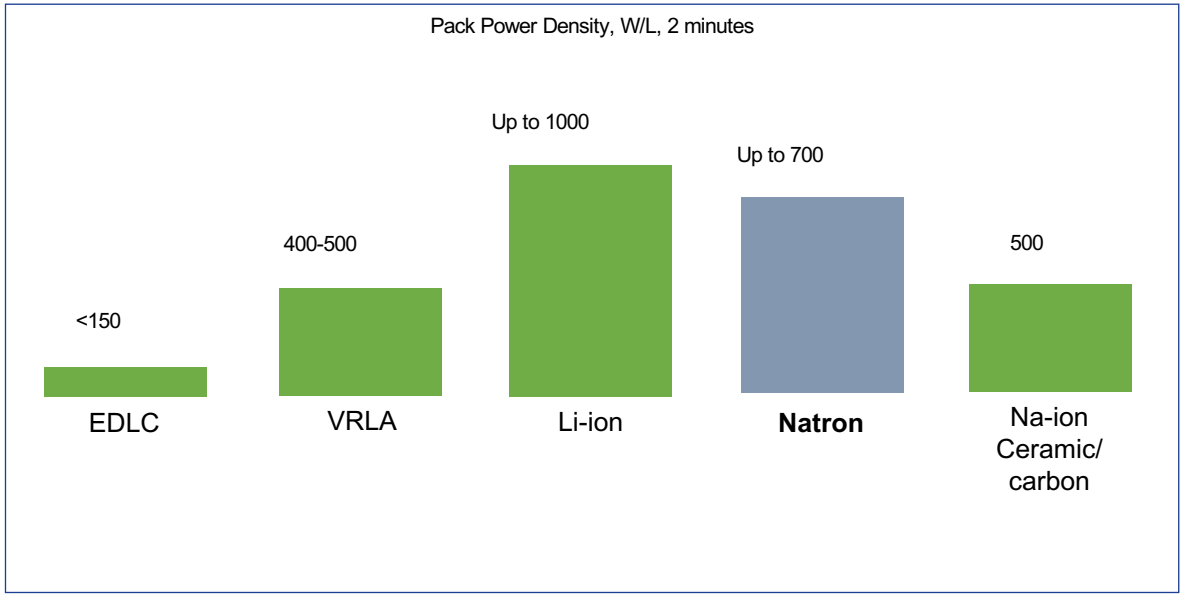


Safe and Fault Tolerant

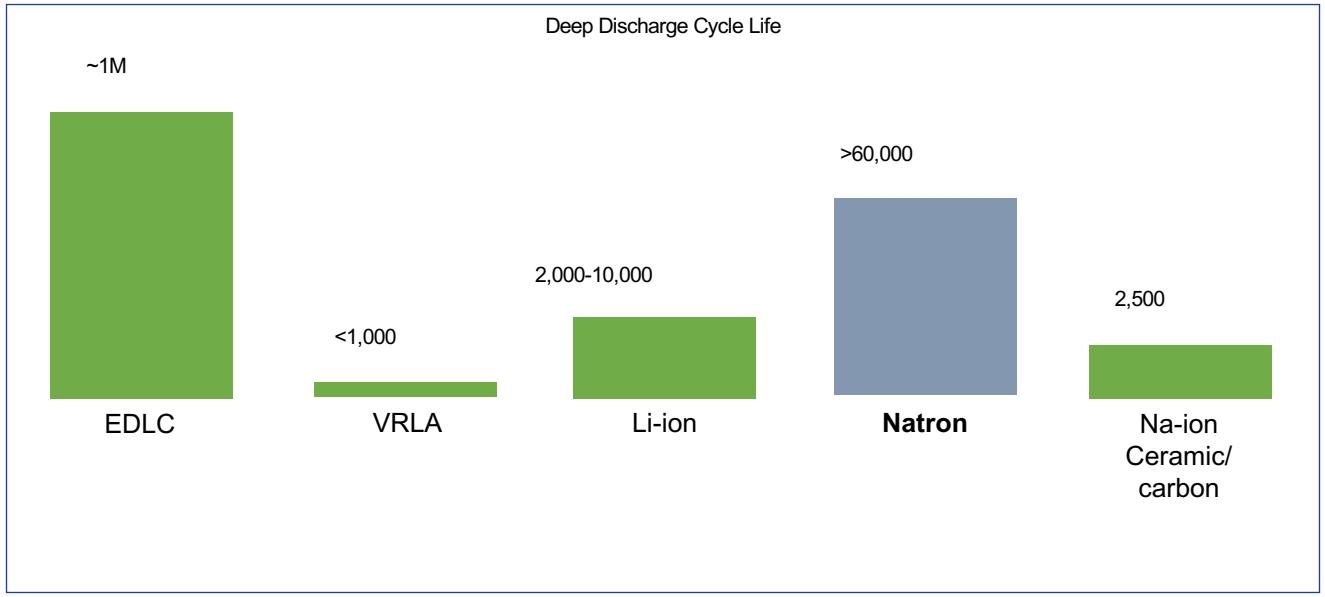


Battery Power / Life Cycle

Pack Power Density



Cycle Life

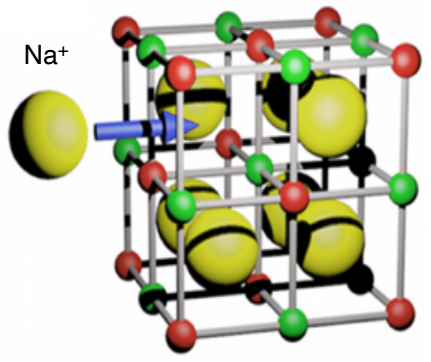


Prussian Blue sodium-ion delivers more instantaneous to 5-minute power per Unit volume at significantly lower cost than ultracaps, better TCO than Li-ion

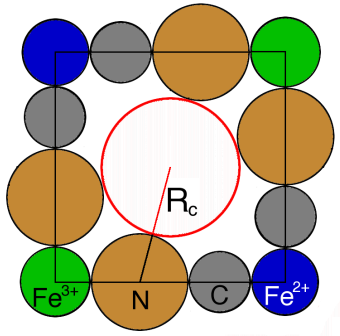
Note: Diesel = 300W/L unlimited discharge period

Na-ion / Li-ion Comparison

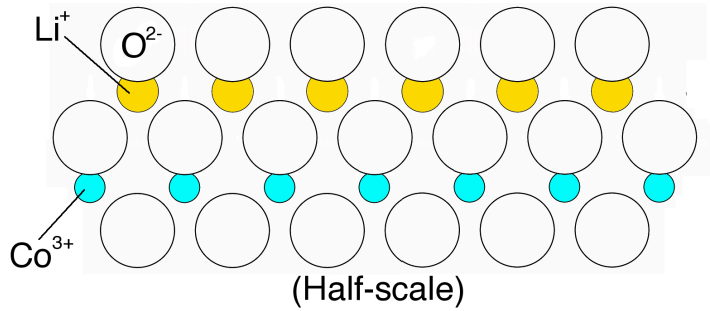
Prussian blues: storage sites are larger than sodium ions.



Prussian Blue



Lithium Cobalt Oxide



Prussian Blue
Channel radius: R_c = 1.6 Å

Larger than Na+ = 1.12 Å

$LiCoO_2$:
Channel radius: R_c = 0.43 Å

Smaller than Li+ = 0.6-0.7 Å

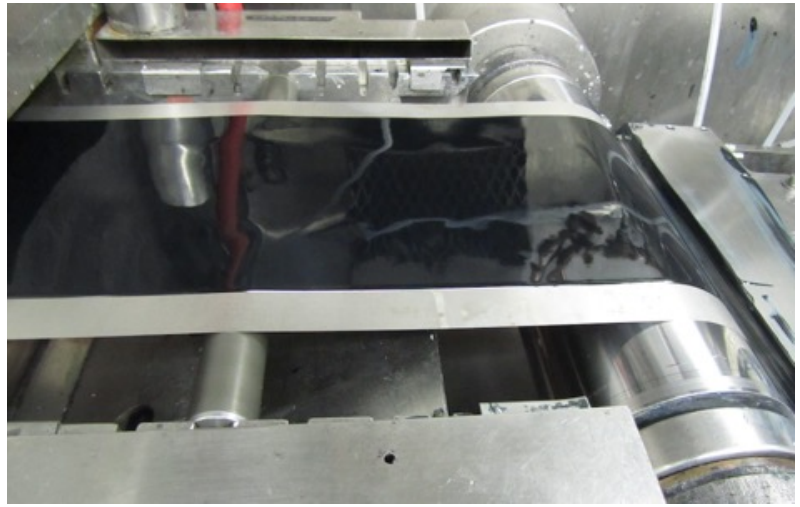
Mission Critical Power article – *Is Battery Technology on the Verge of a Blue Period?*
https://issuu.com/energymagazines/docs/mcp_june_2019_digital_issue/36

Na-ion ½ internal resistance of any Lithium chemistry

Industry Standard Manufacturing

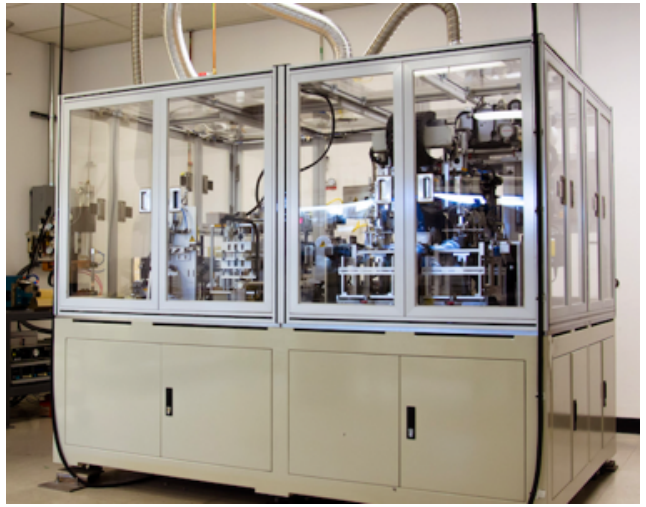
- Prussian blue batteries can be manufactured in any Li-ion plant using standard equipment.
- Electrodes: slurry coating and drying, calendering, slitting/punching.
- Pouch cell assembly: stacking, welding, electrolyte fill, sealing.
- Natron is currently scaling production through existing manufacturers.

Slurry Electrode Coating

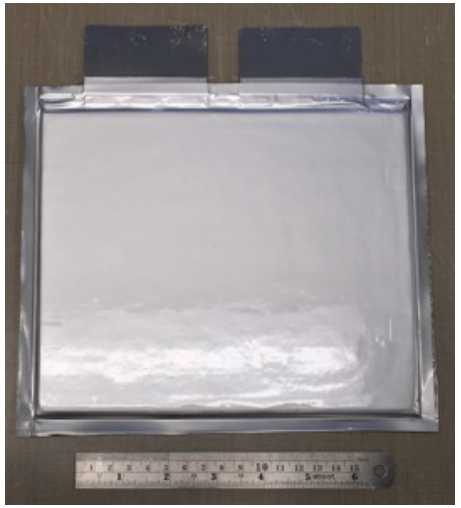


Calendering

Cell Stacking

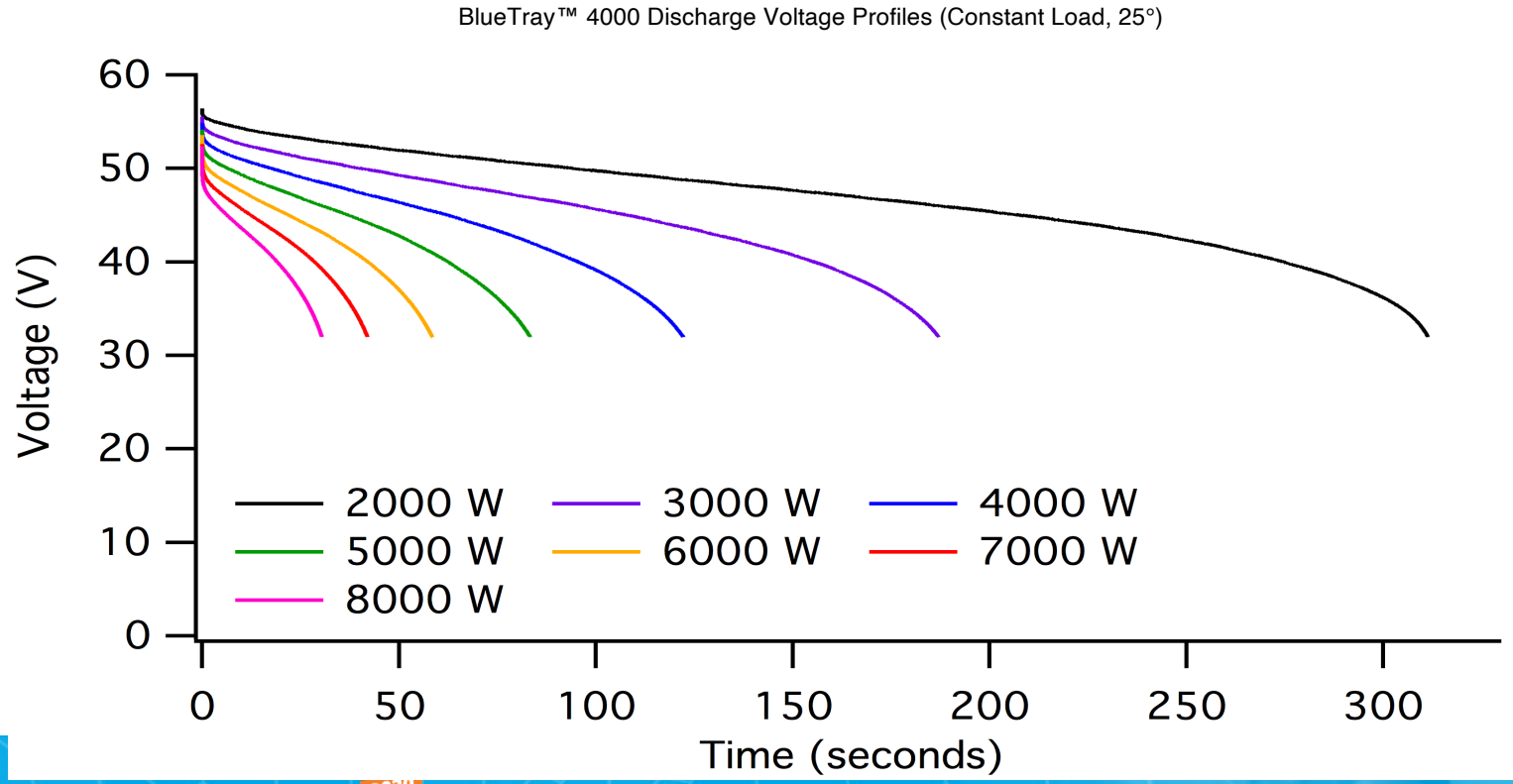


Pouch Cell



Unusual Performance

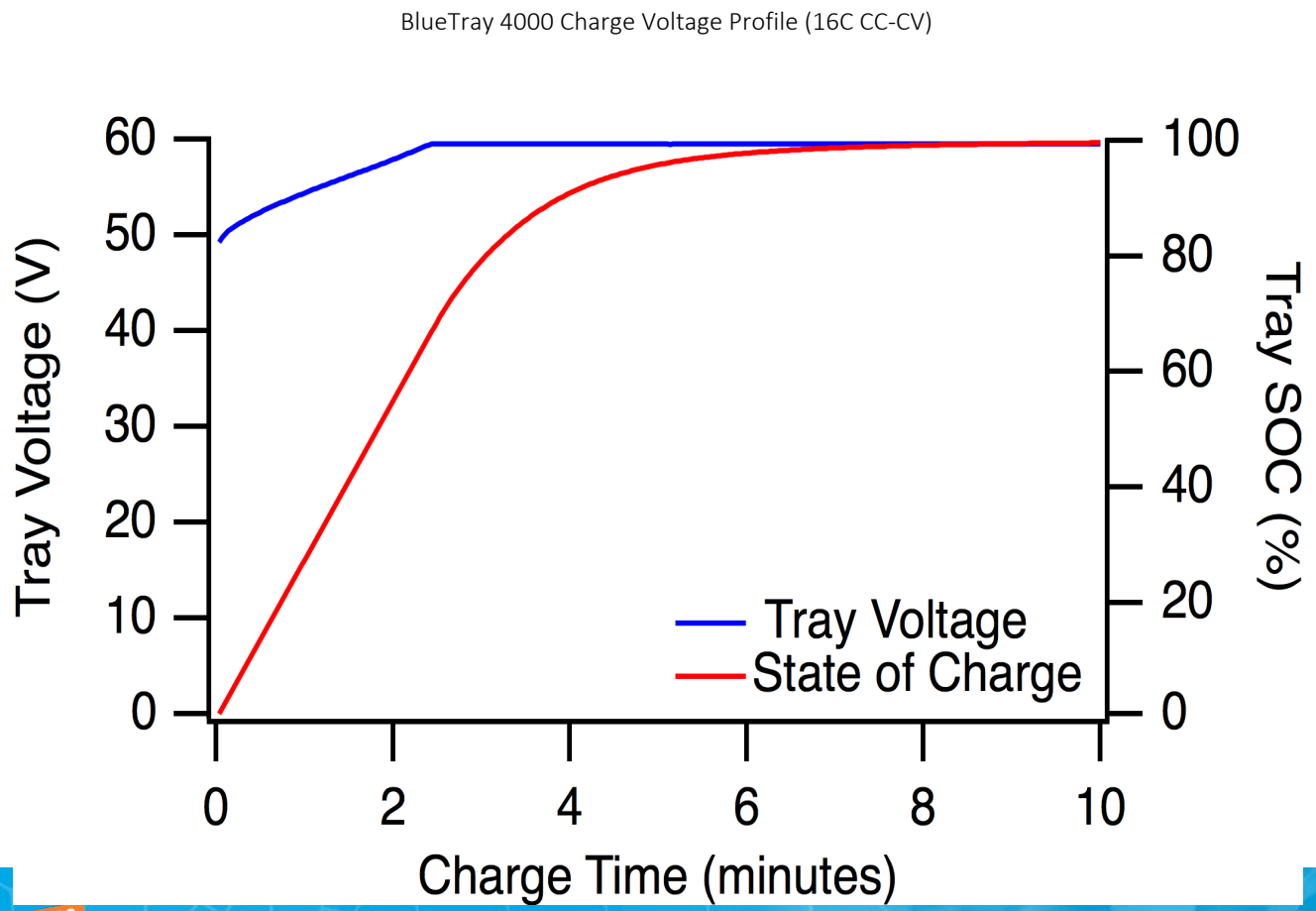
- Natron's battery has half the internal resistance per energy of lead acid.
- This allows a much higher fraction of total energy to be delivered during rapid discharge.
- 70% of rated energy is delivered during 2 minute discharge at 4kW.
- 33% of rated energy is delivered during 30 second discharge at 8kW.



Incredible Availability & Efficiency

- Natron's tray has unique charge acceptance ability: 0-99% SOC in 8 minutes.
  - 0-70% SOC during 16C recharge lasting 2.5 minutes.
  - 70-99% SOC during constant voltage hold lasting 6 minutes.

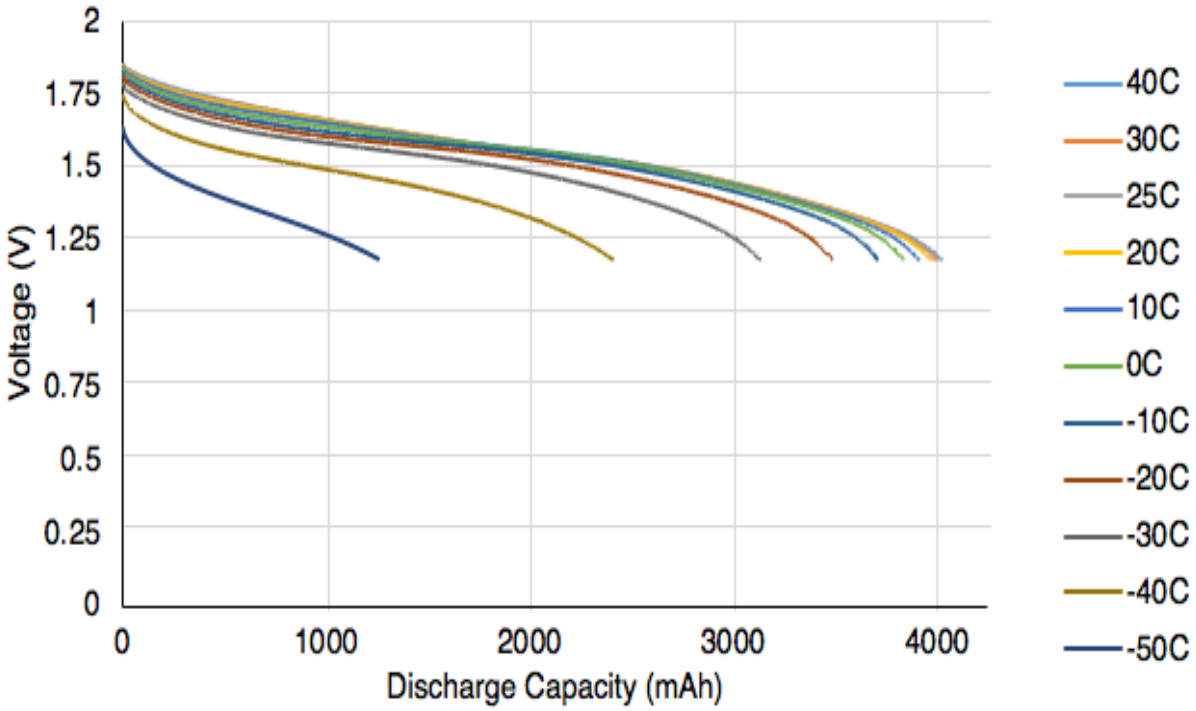
96 - 98% round-trip efficiency



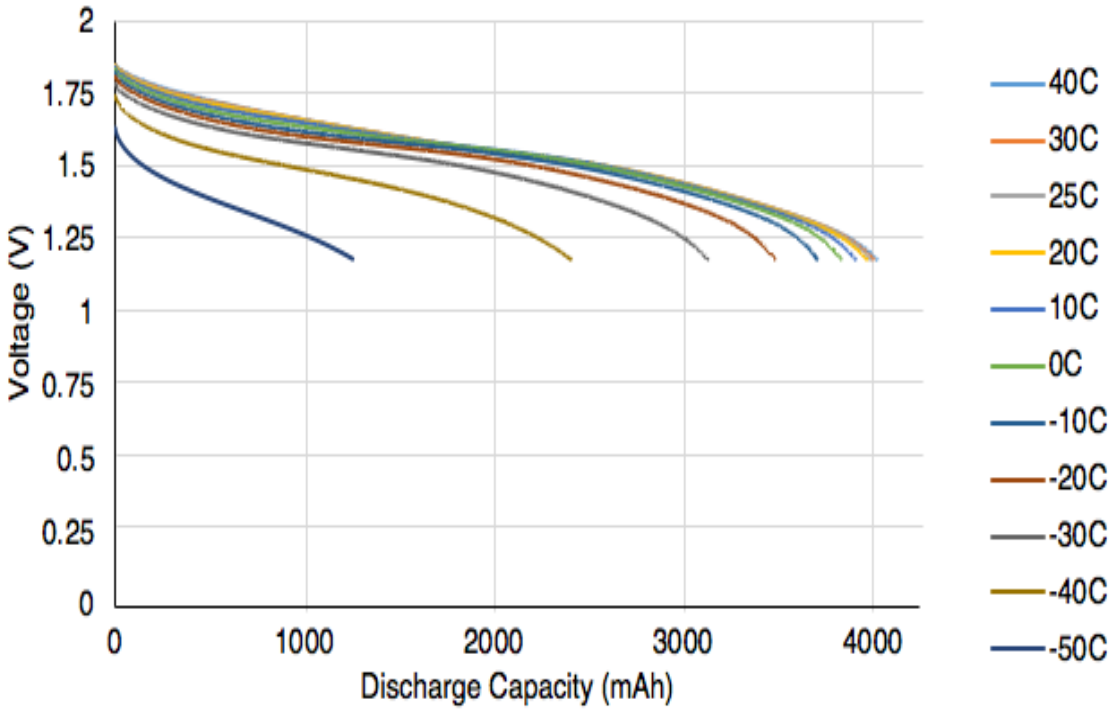
Wide Operating Range

- 96% of cell energy available during 1C discharge at 0° C.
- 76% of cell energy available at -30° C.

1C Cell Discharge Profile vs. Temperature



1C Cell Discharge Profile vs. Temperature



Opportunities

OCP R 3.0 – migrating to 48V DC

Legacy Telecom

Edge

Software Defined Power

Traditional Bridging with new redundancy architectures

Grid Services – behind the meter peak shaving

Grid Service – revenue based: frequency, voltage, DR, etc

ABB Edge Cabinet + Natron Batteries

Distributed Data Center Power Solution

Increased Power Density
Power Density Improvements at the Cabinet

up to 48KW per Cabinet

Pay-As-You-Grow Cabinet Power
Increased White Space Utilization

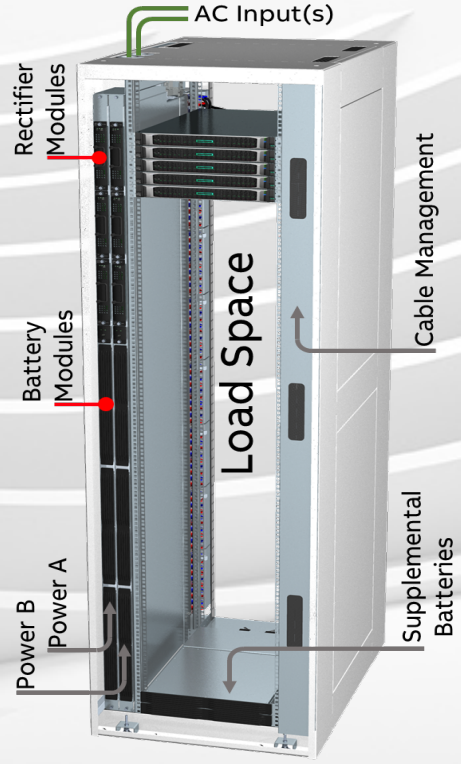
up to 30%+

Reduced Capital Cost
Eliminates Traditional Power Room
Minimizes Battery Cost
Reduces Infrastructure Costs

up to 25%

Reduced Operating Cost
Efficiency Maximized
Losses Minimized
Reduced Utility Cost (energy savings)
Minimal Maintenance Costs

3 Phase AC input
No phase balancing required
Twist and Lock connection



Easy to Move and Install
Hi Capacity Casters and leveling feet

Easy Installation
Rapid Installation and Turn Up
Simplify Upgrades and Expansions
Twist and Lock AC Connection

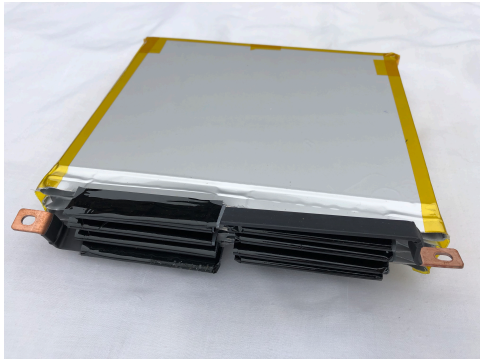
Plug and Play Modules
Rectifiers, Batteries and Controllers
Hot Swappable, Plug and Play

Easy Maintenance
Modules Self Identify with problems
Hot Swap, Plug and Play replacement

Improved Reliability
Dual System (N + N) Redundancy
Flexible Redundancy levels
Improved Availability / Reliability
Fault Domain Minimized to Single Cabinet

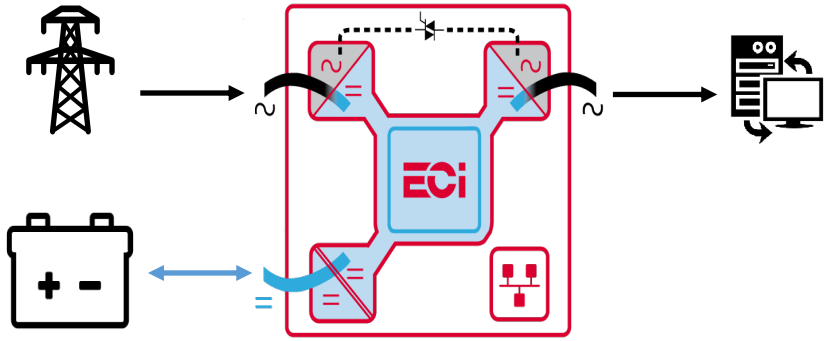
Energy Storage Design Considerations

- Battery is no longer the weakest link
- Ensure Rectifier, Inverter, Wire, Breakers fit power profile
- Think Power over time not total available Energy
- Core battery module – nonflammable, no thermal runaway
- Internal N+1 redundancy at reduced run time
- Lead is NOT Dead!
- Lithium is here to stay, EVs anyway
- Diesel, still your best friend for hours to days of operation

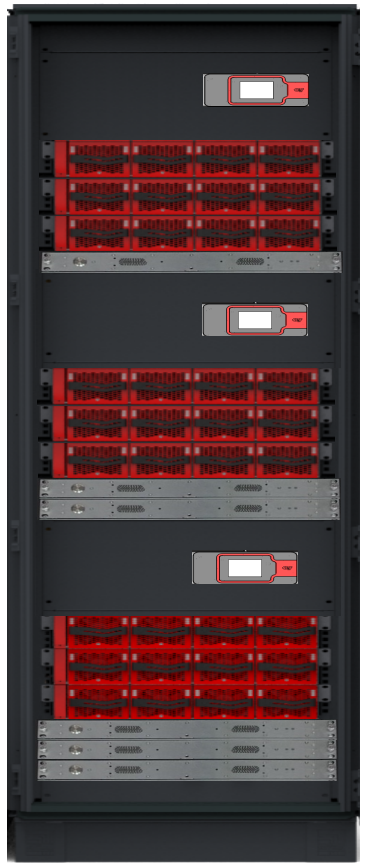


- Enabling Software Defined Power
- Localized energy storage, peak power capping / augmenting
- Extending life of current UPS / power infrastructure

4 – 20 kW power block



MW+ multi-mode Power / Energy system



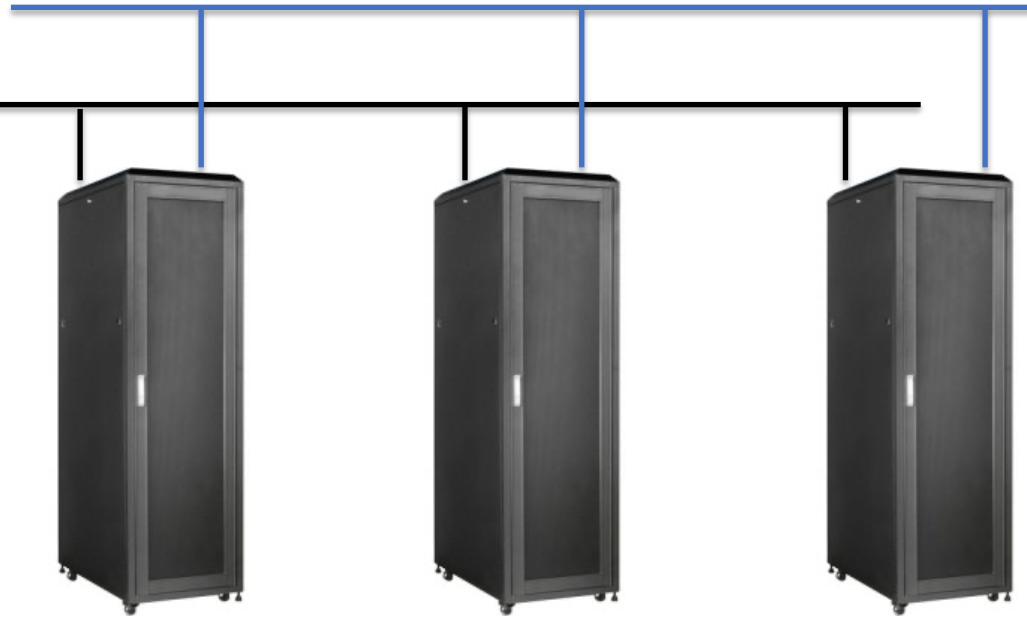
10 – 80 kW power rack

Managing Peak Loads

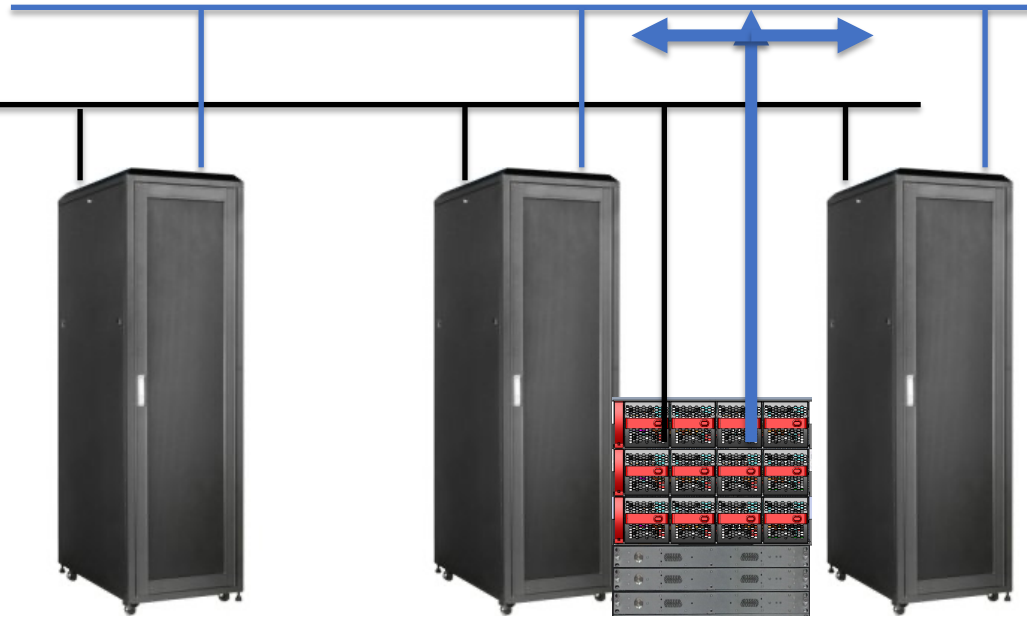
1 MW UPS = 100 10kW cabinets

Real World = 125, 150? Cabinets

Peak Demand Charges – not good!



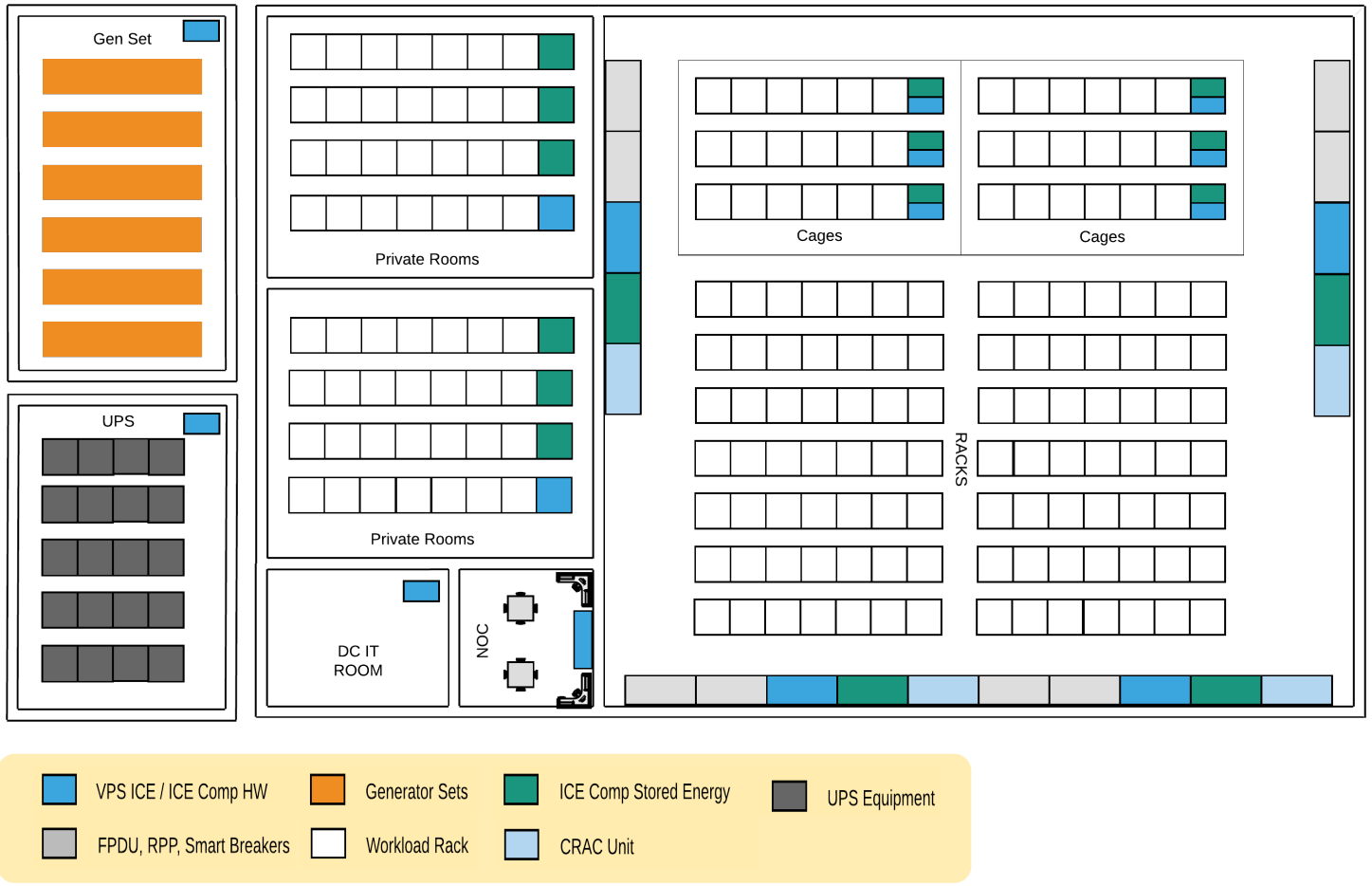
Expand Capacity & Eliminate Peaks



In Rack Battery / Inverter Power Blocks
Real-Time power capping
Add capacity on the fly

New revenue streams
1 to 5 minute peak charge to clients
OPEX improvements

SDP Data Center Deployment Options



- VPS ICE can reside on a server anywhere within the DC if it is on the same network VLAN where all the ICE Compatible HW are connected, ideally on a redundant power and network rack in the IT Room or Network Room. The ICE Console can be monitored through the NOC.
- ICE Compatible HW can be placed in the customer racks, on the walls next to PDUs, RPPs, CRACs
- Natron Energy sodium-ion batteries enable energy storage / management on the data center floor
- UL9540A nonflammable, no thermal runaway
- NFPA 855 compliant
- >50,000 cycles

Diagram property of Virtual Power Systems, see http://www.virtualpowersystems.com for more information

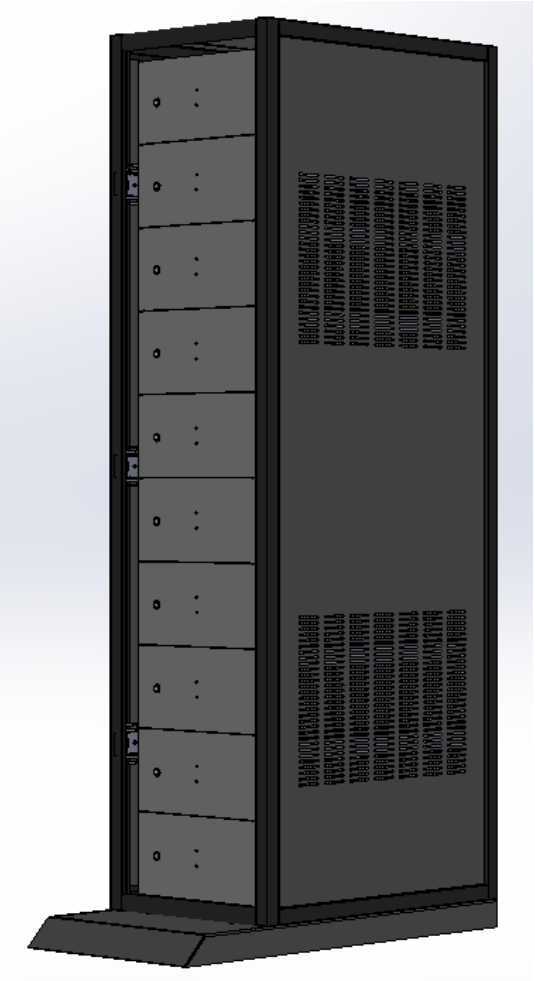
OCP Data Center Deployment

H5 DATA CENTERS

- Recently deployed at H5 Data Centers Phoenix campus
- Forced Physics DCT high-density innovative cooling IT stack
- Backup power via Natron Energy 1U batteries

New Battery Plant Configurations

- High Peak Power capacity eliminates need for N+1 (N+ many)
- 52U standard IT cabinet form factor 1000mm deep
- Higher power cabinets enable 1,600 kVA and 2 MVA UPS power blocks
  - Fewer strings
  - Higher per cabinet standard power
  - Significantly higher Peak Power capacity
- 300kW per cabinet ‘nominal’, 3-minute discharge EOL rating
- 400kW+ peak, 90-second discharge EOL rating
- 4 cabinets to make 1,200 kW power block
- Fail One – 3 remaining cabinets make 1,200kW @ 90-seconds



Won’t Dig or Build Our Way to 1,000 TWh with Lithium Alone

Greenpeace doesn’t like Tar Sands just wait until they focus-in on Lithium and Rare Earth Metal extraction and processing

Chemistry World article: A Battery worth its Salt - https://www.chemistryworld.com/features/a-battery-technology-worth-its-salt/3010966.article#/

Next Steps

- Come visit Now – Virtually or when you are in the Bay Area post COVID-19
- Shipping UL Listed1U batteries today
- Shipping Software Defined Power systems with VPS and CE+T
- Edge and Telecom applications available now
- Contact one of our Integration Partners for configuration assistance
  - ABB, C&C Power, CE+T, LBS Power, Rhombus Energy Solutions, VPS
- Participate in our 300kW+ cabinet development and testing
- Explore the merits of Software Defined Power for Peak Shaving, Storage, behind-the-meter applications

- Call, email anytime with questions, wild ideas, data & demo requests

Thank You!

Jack Pouchet
+1 949.351.8142
jack@natron.energy
www.natron.energy
Twitter: @JackPouchet
LinkedIn: https://www.linkedin.com/in/jack-pouchet-aa569a/
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Software Defined Power: https://natron.energy/wp-content/uploads/2019/09/VPS_Natron_Press-Release_09_23_2019_NatronRev.pdf
EV Fast Charging: https://natron.energy/wp-content/uploads/2019/09/Natron_CEC_Press_2019.pdf