Telecom/ICT Backup Power – Where is it Going?

Curtis Ashton
Training Director
American Power Systems LLC (a DC services division of East Penn / Deka Batteries

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What We Will Cover (Briefly)

- Are 3-8 hr + Backups Going to Be Less?
  - Less or More Reliable UPS?
    - and UPS Backup Times
- Distributed vs Centralized Power
- How to Meet Long Duration Backup Mandates
  - Is Li-ion Getting Safer?
- Additional Battery Chemistries Available for Telecom

Historical 3-8 hr Battery Backup of Telecom COs/RTs and 5-15 Minutes for IT DataCenters

- 3-4 hrs for COs with Permanent Auto-Start Auto-Transfer Engine-Alternators Allowed Time to Dispatch and Fix Most Engine Problems
  - 8 hrs for Sites w/o Permanent Engine Allowed Extra Time to Retrieve, Tow, & Hook Up Portable Genset
  - these Long Backup Times Possible Because Historic Telecom Heat Loads only 7-35 W/ft^2
- Early IT/DataCenter Backup 15 Mins to Allow Orderly Computing Shutdown w/o Loss of Data
  - Heat Loads High Enough (80-200 W/ft2) that Longer Backup Times Do No Good Because Computing Equipment Will OverHeat after 30-45 Minutes Depending on Heat Load Density
  - Data Loss on Shutdown No Longer an Issue, so 5 Min Backups for Centralized UPS More Common
    - Typically 1-2 Mins to Start All Paralleled Engines and Transfer Loads
    - Distributed UPS Typically 45-90 secs Due to New Power Designs (Fewer Engines to Parallel per "Module")
      - Engine Redundancy (N+1) – COs Probably Need This for Reliability if Desire is to Reduce 3-8 hr Backup Time

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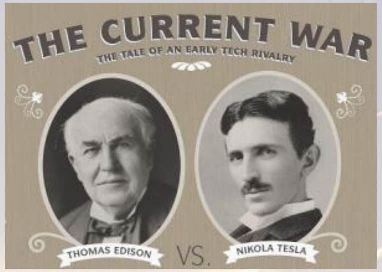
Reliability of UPS vs DC Plant



- According to Intelec (IEEE PELS) Whitepaper from 1998, Single UPS (1N Architecture) 27x Less Reliable Than Typical 48VDC Plant
  - Most DataCenters Have Adopted Much More Reliable Architectures Nowadays
    - Tier IV DataCenters Have Redundant AC From 2 Different Substations
    - Willing to Operate at Lower UPS Conversion Efficiency in VFI (True Double-Conversion) Mode
    - While Single Flooded String More Reliable than Single VRLA or Li-ion String, Multiple Parallel Strings (that most now Use in Centralized UPS) of the Latter 2 Types are 4x+ More Reliable Than 1 Flooded
    - A/B Powering of Individual Shelves Borrowed from Telecom (They Call it "Dual Cording")
    - Centralized UPS Redundancy
      - 2N or "Catcher" (and/or N+1) Systems
    - Distributed UPS Reduce Single Points of Failure and Decrease Conversion Efficiency Losses
    - Internal Redundancy in Some UPS
    - Transfer to Shared Computing
      - Other Racks or Other DataCenters

Modern IT UPS Reliability Schemes

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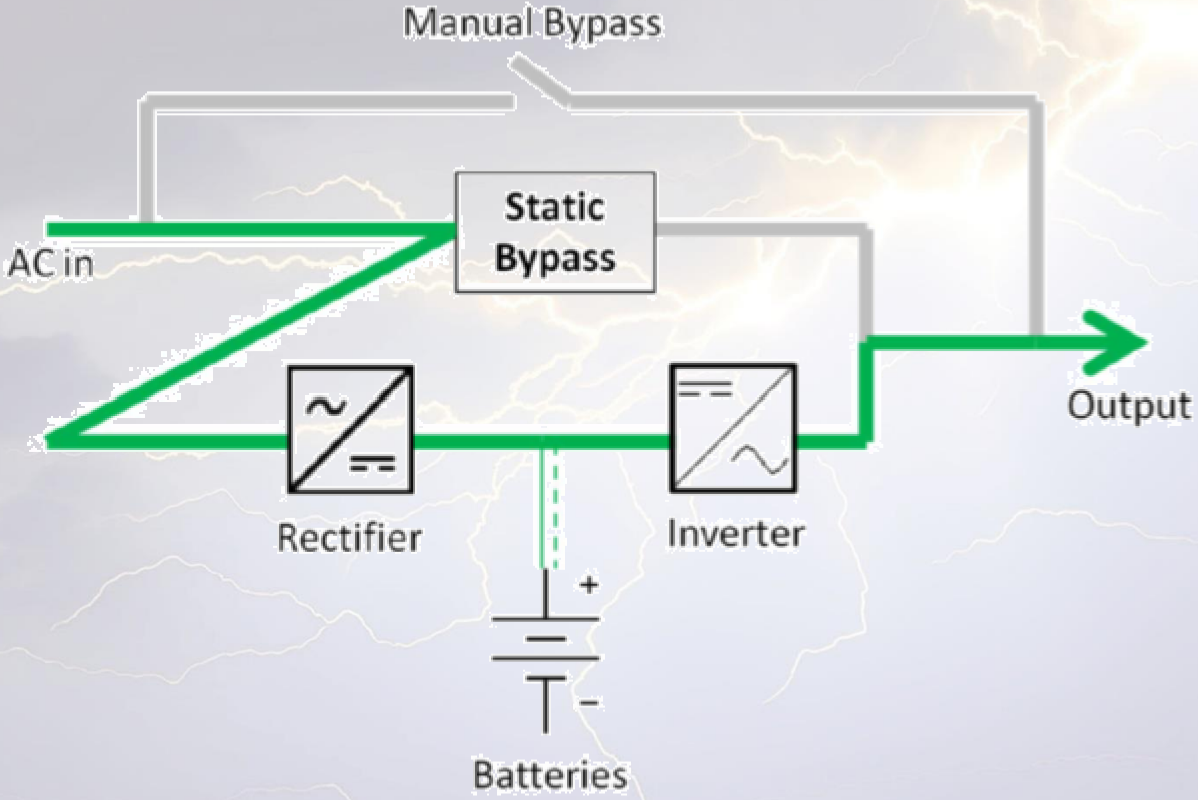
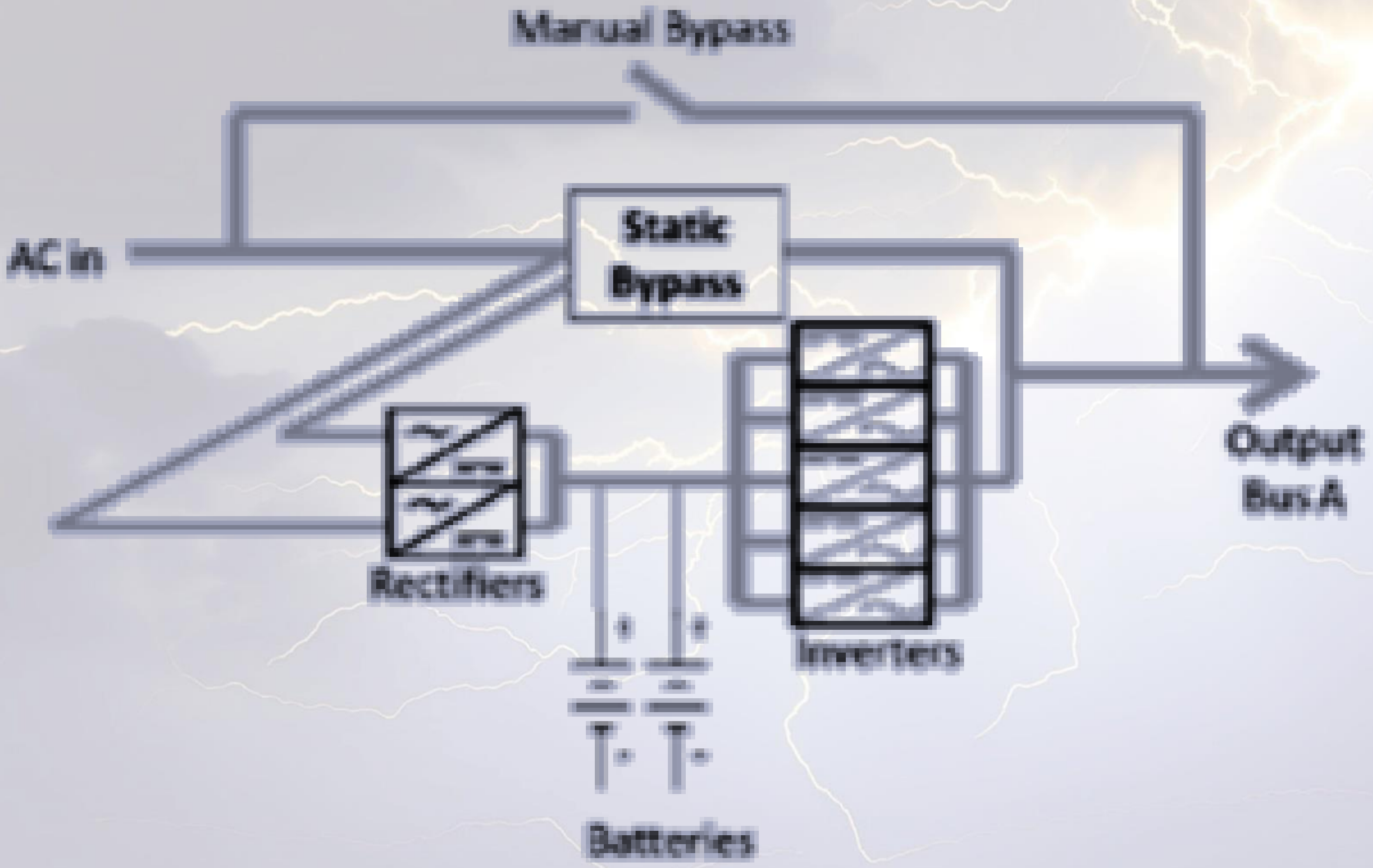
Dual Conversion (Less Efficient, but Far More Reliable)



Internal Redundancy in All UPS Components



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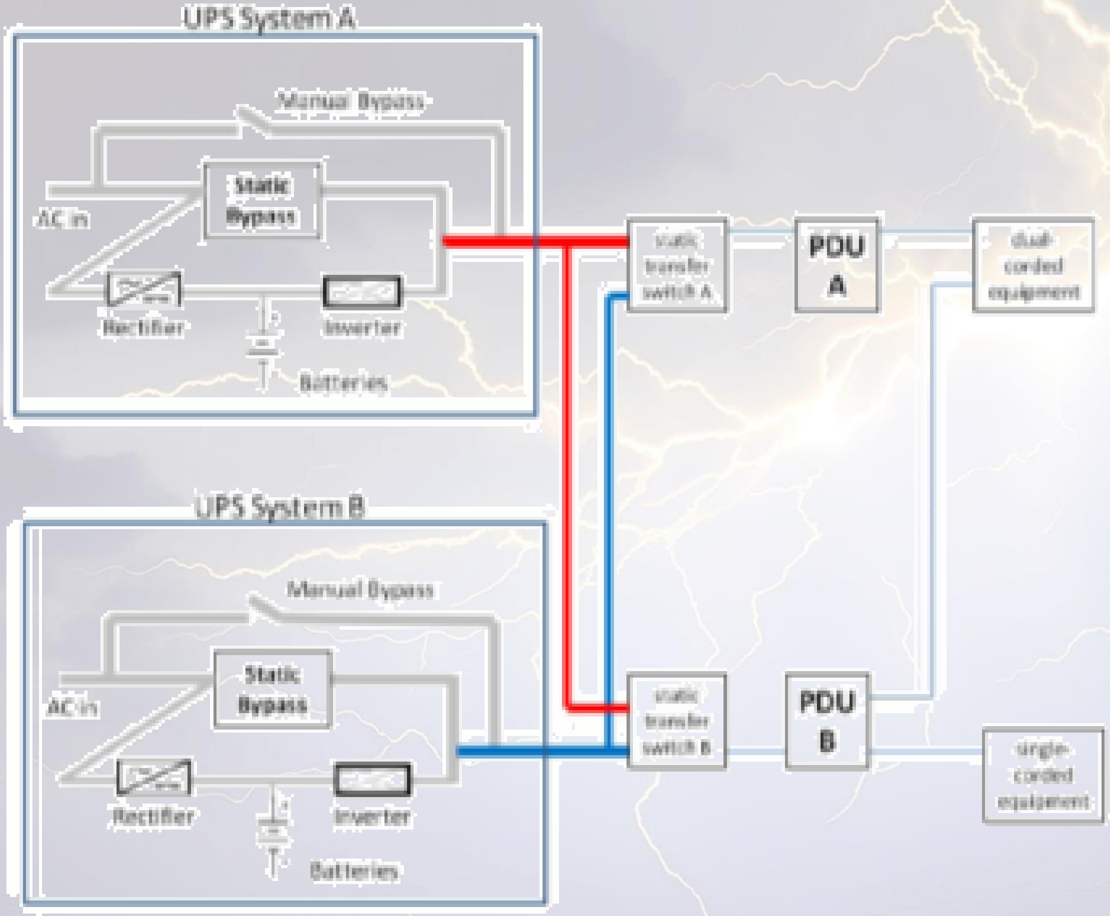
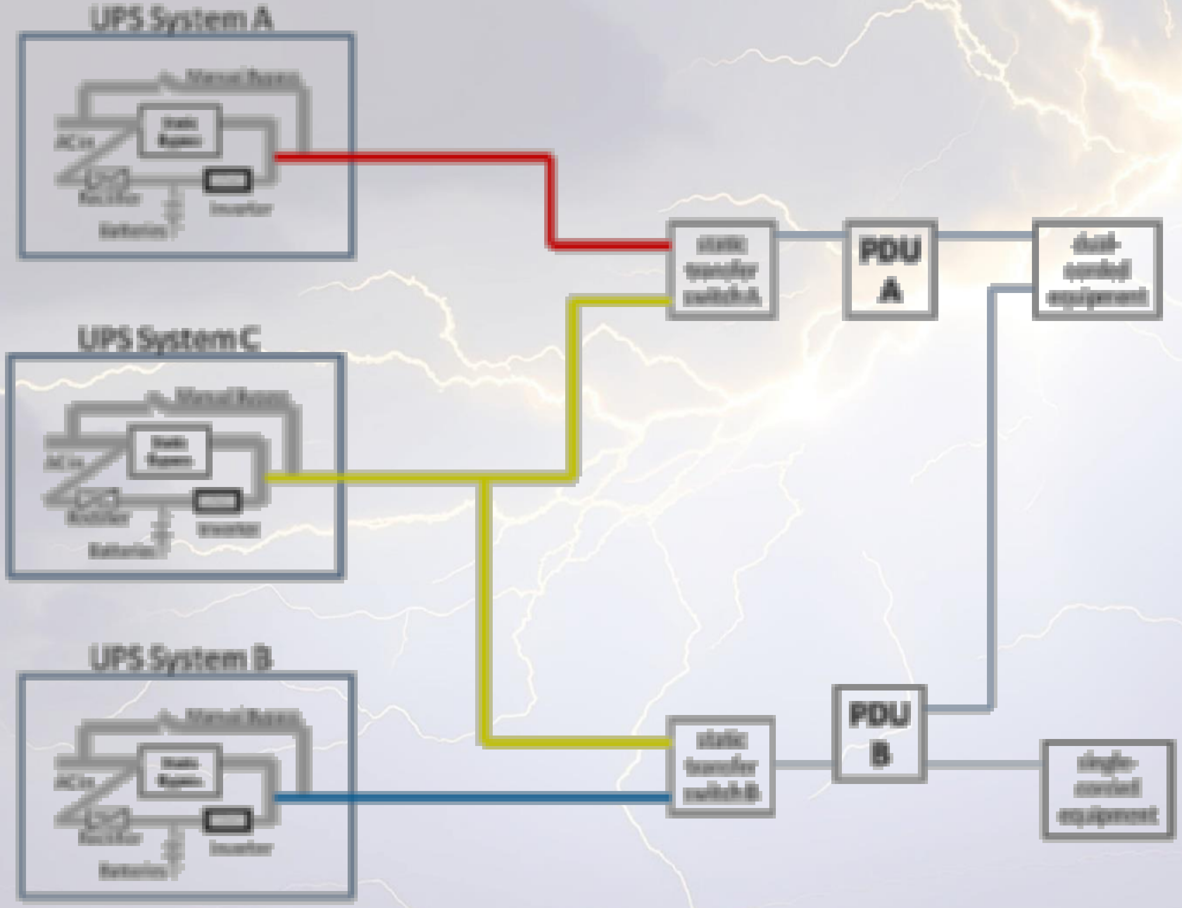
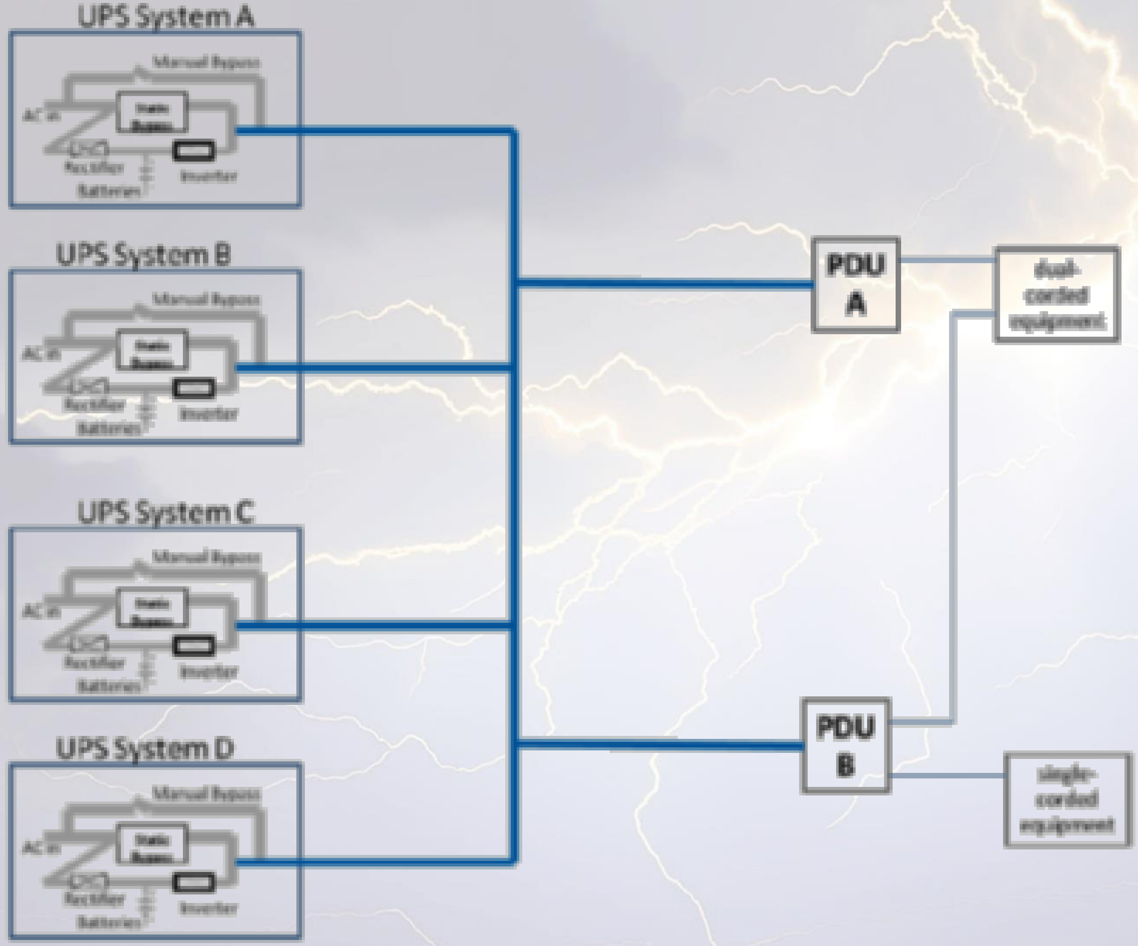
2N Architecture



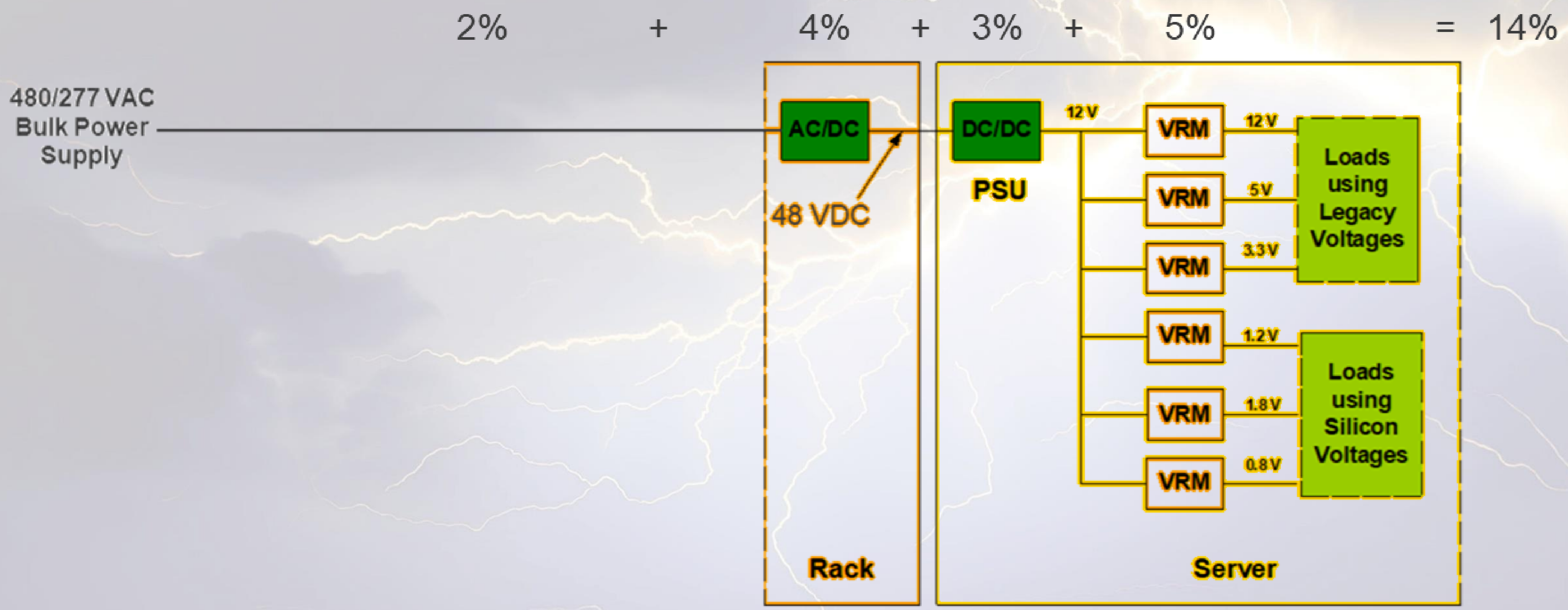
"Catcher" System



N+1 System


UPS System A
UPS System B
UPS System C
UPS System D
PDU A
PDU B
dual-corded equipment
single-corded equipment

DC Architectures (230 or 380) For Energy Savings



Options to Meet Long Duration Backup Mandates

- More Batteries
  - Lead-Acid Not the Most Space-Efficient
    - Li-ion Potential Fire Code Spacing Issue > 50 kWh
      - And is a Relatively High Fire Risk
        - » Stick with UL 1973 LFP
- On-Site Power Generation w/ Ride-Thru Batteries
  - Engine-Alternators
    - Potential Issues with Diesel Emissions and Noise
      - Natural Gas or Propane?
  - Fuel Cells
    - Hydrogen Storage and Transport Issues
      - Methanol or Propane (LPG) Reformers
    - Fuel Cells Usually Take More Space than ICE and Cost at Least 2-10x

Backup type	Wh /kg	Wh /L	float yrs	High° effect	Low ° effect	Maint-enance	thermal run/ walkaway	$/ kWh
Li-ion LFP	95	100	10-15	-45%	heater?	3 yrs	< most Li	400
Li-ion LMO	90	120			can't do		Yes	550
Li-ion LTO	80		20	-35%		5 yrs	not yet	600
Li-ion NCA	130	120	15	-45%	can't do	4 yrs	Yes	700
Li-ion NMC	170		10-15			3 yrs		550
VRLA blocs	40	90	2-11	-50%		6-12 mo	old/short	200
VRLA 2V	30		5-17					300
Ni-Cd	55	80	25	-20%		18-36 mo		625
NiZn	70	115	13	-30%		3 yrs		650
$ZnMnO_2$	50	80	10	-45%	-50%	2½ yrs	N/A	300
$Ni\text{-}H_2$	30	35	25	-20%	0%	6 yrs		650

Example Technology Comparison for 72 h Backup Assumptions and Notes

- Outdoor Cabinet to Power
  - 750 W Fairly Constant Power Load @ Nominal -48 VDC
    - Fresno Climate Assumed for Sizing and Lifetime of Batteries
    - LFP Only Technology Requiring Fire Code Spacing > 50 kWh
  - 20 yr Lifespan, assuming post WWII US avg Inflation Rate of 3.74% and ROI of 10%
  - Up Front Costs Include Costs of Cabinet(s) and Install
  - Assumed Height Limits of 72” in ROW
    - 3’ Minimum Working Clearances Factored into Space
      - 10’ Offset Required for LPG
  - Presently Available NiZn and $ZnMnO_2$ Products Float Too High (> 60 V)
    - LTO Can Float Correctly, but Presently Available Products Only 35 h @ 750 W
    - $Ni\text{-}H_2$ Could Float Correctly if Electronics Were Designed for it, but Not Yet

Example Technology Comparison 72 h Backup Table

Technology	Sizing	init$	avgLife	Replace$	Space	Weight	M$/yr	NPV
VRLA monoblocs	9, 200Ah strings	$48,000	7 yrs	$21,000	100 ft^2	7,800lbs	$ 600	**$77,000**
VRLA 2V	2, 900Ah strings	$56,000	13 yrs	$30,000	105 ft^2	8,800lbs	$ 300	**$73,000**
LFP	8, 200Ah mods	$59,000	12 yrs	$32,000	155 ft^2	3,400lbs	$ 100	**$76,000**
Ni-Cd (TelX)	9, 172Ah strings	$89,000	25 yrs	$ 0	100 ft^2	5,200lbs	$ 150	**$91,000**
LPG DC Genset	6kW; 2 100lb tanks	$13,000	13 yrs	$ 9,000	170 ft^2	400lbs	$1,800	**$39,000**
methanol Fuel Cell	2, 500W; 40L	$89,000	20 yrs	$ 0	75 ft_2	1,200lbs	$ 900	**$99,000**

LPG DC Output Genset

2V VRLA Solution Example

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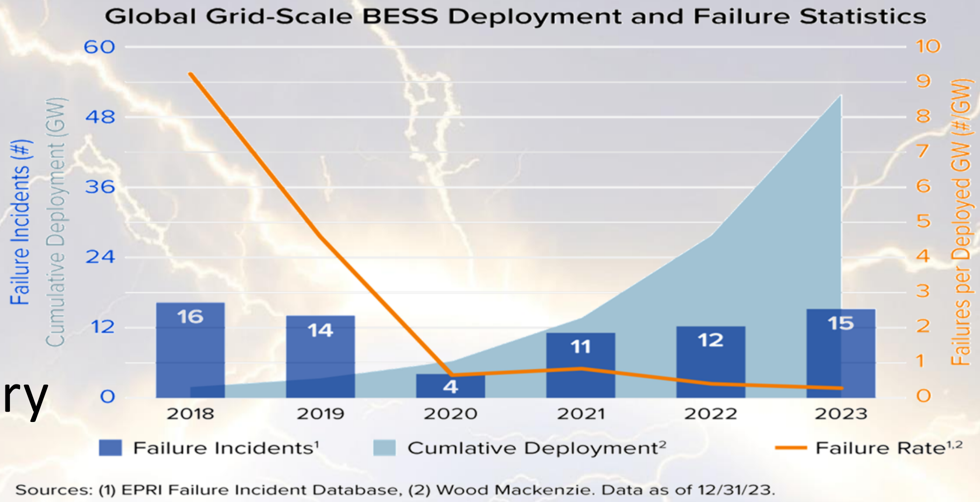
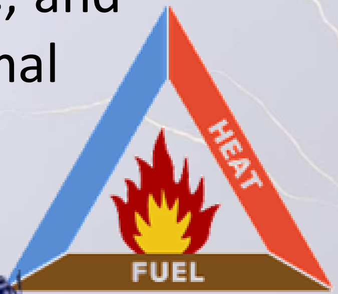
Is Li-ion Getting Safer?



- LTO is Present Safest Li-Based Chemistry
  - Least Energy Dense & aMore Expensive Li Chemistry
  - Limited Manufacturer's and Products
- LFP is 2nd Safest Li-Based Chemistry
  - Medium Energy Density
  - About Half as Likely to Go Into Thermal Runaway as NCA, LMO, and NMC; and For UL 1973 Listed Modules About ⅛ as Likely to Have Propagating Thermal Runaway
- Long Term Safety Solution is Solid State (Polymer or Ceramic/Glass Electrolyte) Li-ion
  - Beware of Li-Metal Solid State Solutions (Remember Avestor!)



How to Contact Me

- curtisashton@ampowersys.com
- (720) 845-0846

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Questions?