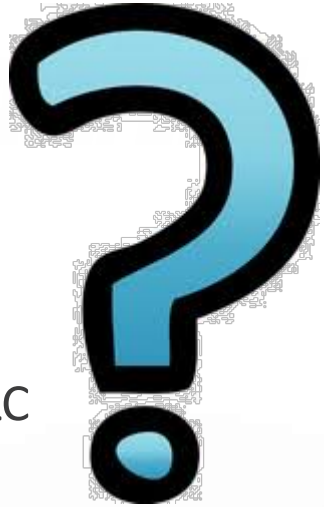
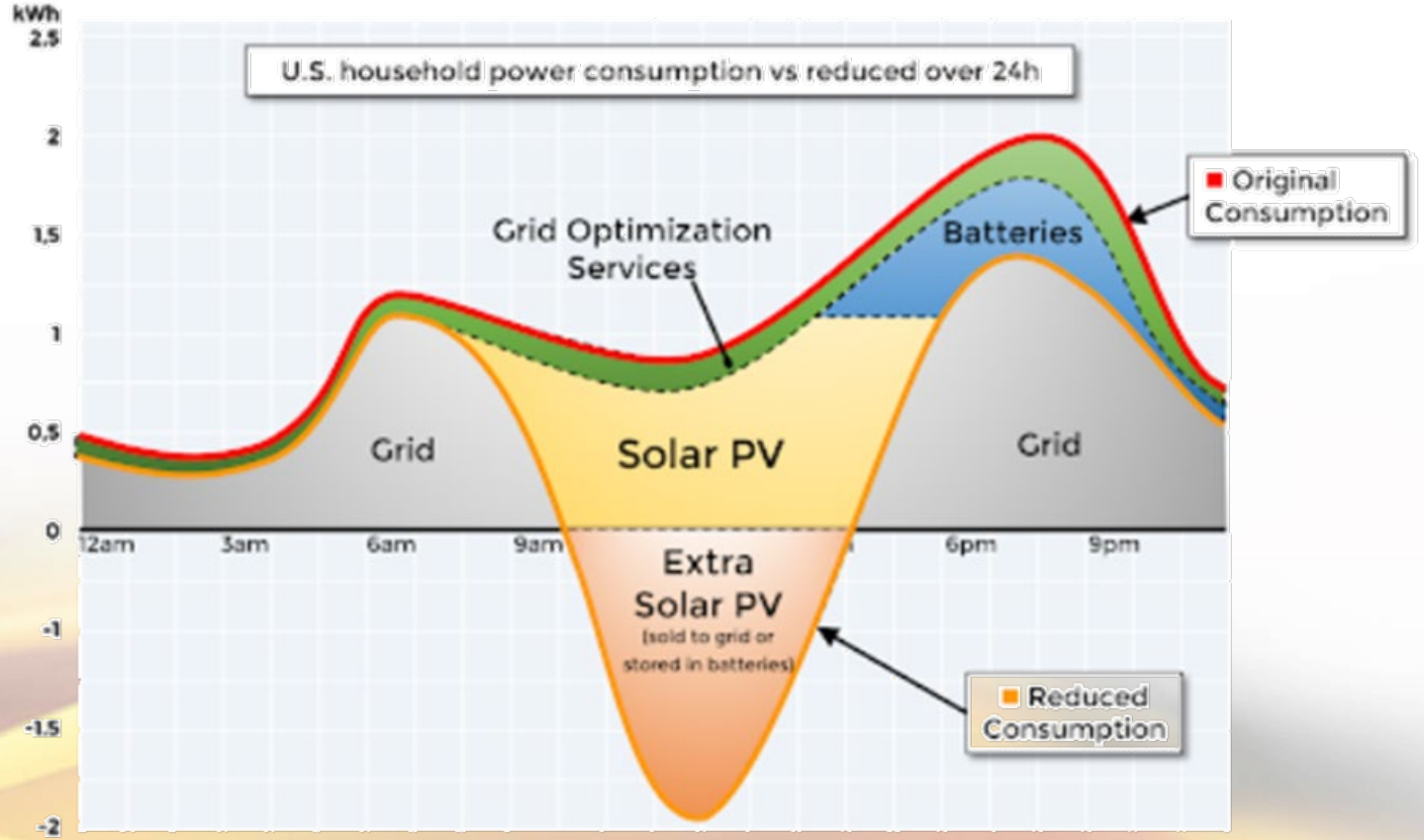

CCI
EASTPENN
AMERICAN
POWERSYSTEMS
Good Facts to Know
about Li-ion BESS

Who is This Dude?



- Curtis Ashton
  - Electrical Engineer & Master Electrician
  - Employment History: SRP, USWest/Qwest/CenturyLink
  - Employer: Training Director for American Power Systems LLC (subsidiary of EastPenn/Deka Battery Manufacturing)
  - Past Chair of IEEE PES ESSB (Energy Storage and Stationary Battery)
    - WG Chair, Vice-Chair, Technical Editor, Primary Author for a Bunch of IEEE and ATIS/ANSI Battery Standards
  - Member of NFPA 855 Technical Committee
    - Chair of 3 Task Groups within Committee

Why Storage



Source: Id Energy

Li-ion Accounts for 95% of Global ESS Installs

Source: Silicon Ranch Corporation

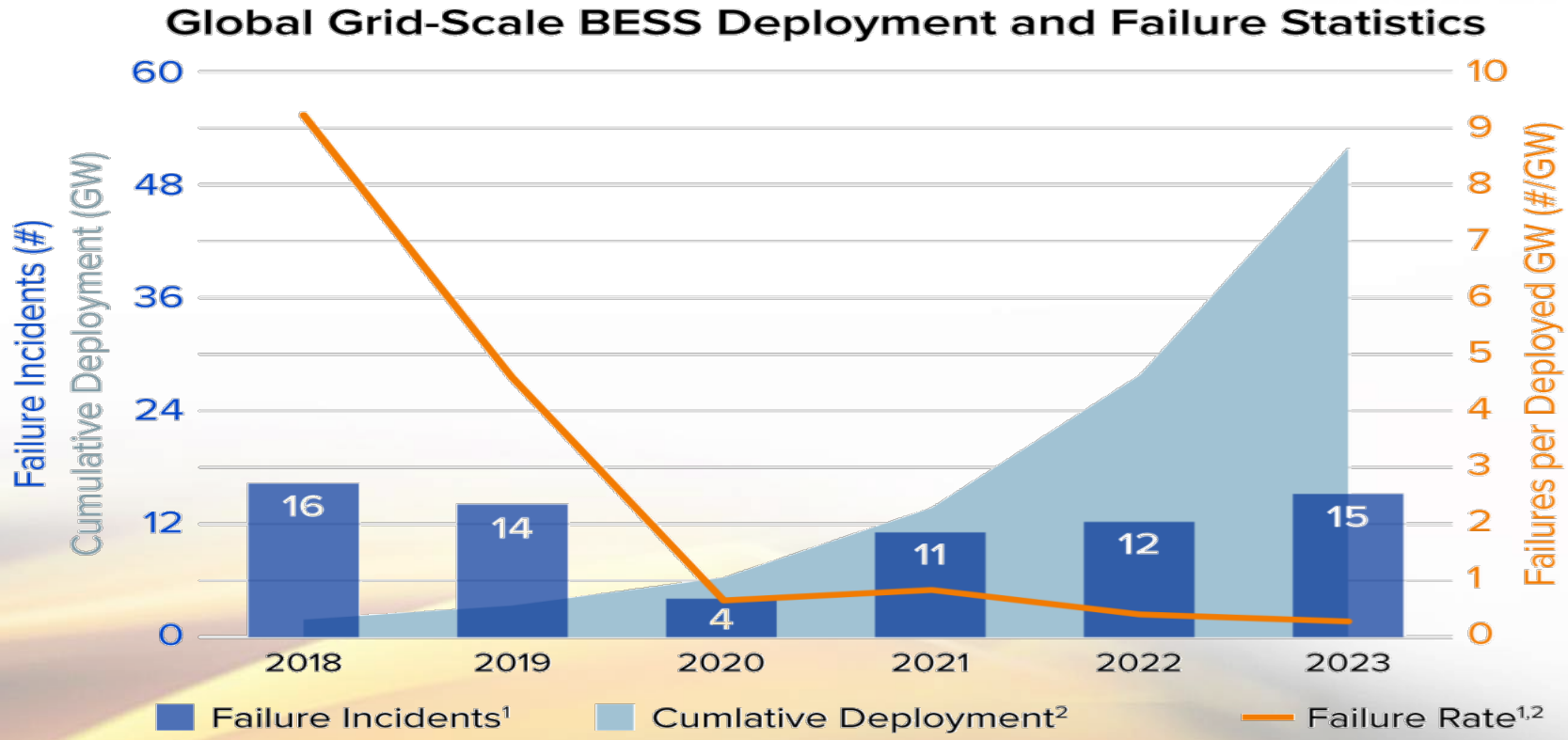
Why Li-ion vs Other Batteries if Less Fire Safe?

1. Space (½ most others)
   - Space Advantage Goes Away Indoors if Newer Fire Code Adopted
2. Weight (¼ - ½ most others)
3. Cycles (3x most others)
4. Monitoring (built in with Li-ion BMS)
5. Maintenance (⅓ traditional)

Why is there So Much Concern About Li-ion if we All Carry One in our Pockets?

- Internal Short Circuits Causing Overheating of Individual Cells
  - Manufacturing Defects (1 in 40,000,000 cells) Leading to Shorts (Typically)
    - Used to be 1 in 10,000,000
  - OverCharging (Failure of the BMS)
  - Mechanical Damage (e.g., car crash)
- Inherent Flammability Issues
  - High Stored Energy Density
  - Flammable Electrolytes
  - Oxide Positives that Release O_2 at High Temperatures
  - Graphite (Carbon) Negatives that Release Lots of Soot
- Cell-to-Cell Propagation
  - A Little Fire Gets Really Big
    - A fire of a Single Cell in a Galaxy S7 Note, or 3 cells in a Laptop is Pretty Small (Toss it to the Side and Let it Burn), but a 13.5 kWh “usable capacity” residential “Powerwall” has approximately 2,000 cells in it

Is the Safety Improving



Sources: (1) EPRI Failure Incident Database, (2) Wood Mackenzie. Data as of 12/31/23.

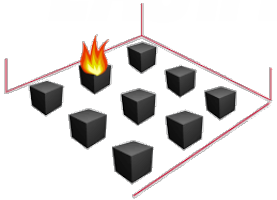
Source: Id Energy

What Changed to Greatly Increase Fire/Safety?

- IEC 62619 (2017) and UL 1973 (2018 Edition) Added Cell-to-Cell Propagation Testing
  - UL 9540A Large Scale Fire Testing
  - These Drove Better Internal Module Designs to Limit Propagation, and Choice of a “Safer” Technology (LFP) for BESS
- Model Fire Codes:
  - IFC-2018 First to Really Address Li-ion Batteries
    - Latest Edition (2024) Refers to NFPA 855 (2023 Edition) for Batteries
      - 855 Requires ≤ 30% SOC Indoor Storage without Special Mods
  - NFPA 1-2021 Referred Directly to 855 (2020 Edition) for Batteries
  - Adoption by Jurisdictions of Latest Fire Code Can Take Years
- IATA/ICAO 30% SOC Max For Air Transport Since 2018/2023
  - Same Rule May be Coming for Rail (RID), Ships (IMDG), and Trucks (ADR)?

Key Model Fire Code Rules to Limit Propagation

- 3’ Spacing Rules for 50 kWh Indoor
- 10’ Outdoor Container Spacing
  - This is a Huge Change and has Mostly Limited Fires to Single Container
- Forcing UL 9540 Listing (Which Includes 1973) and UL 9540A Large Scale Fire Testing
  - Leads to Less Thermal Chemistry Choices and Lower Propagating Designs
- Deflagration Venting
- Movement Towards Moving Residential Li-ion BESS Out of Living Spaces and Eventually Even Out of Garages



Evolving Li-ion FireFighting Suppression Strategies

- **Copious** Amounts of Water
  - Clean Agent or Nitrogen Suppressants Have Lost Favor For Large Scale Use Because Li-ion Produces its Own Oxygen
    - Possibly Targeted Nitrogen or Clean Agent or Water Based on Early Detection Technologies
  - Let it Burn and Put Water on it From the Outside
    - Don't Open the Doors to Allow Oxygen Back in such that Reignition can Occur Until You've Put Copious Amounts of Water on it
  - Higher Flow Sprinklers (About 3x Typical)
    - AHJs May Allow StandPipes for Remote Sites w/o Water on Site?

Present & Future Safety Improvements in Li-ion

- LTO a Very Safe Chemistry
  - Costly and You Lose Space Advantages
- LFP Better Safety then NCA, LMO, LCO, & NMC
  - About 4x Safer / Less Likely to Be Set Off / Propagate
  - ½ Gasses, ½ Heat
  - Still Lots More Unsafe (Firewise) than Lead-Acid, Ni-Cd, NaNiCl, etc.
- Solid State (probably at least 5 yrs out full commercialization)
  - Replace (≥ 90%) Flammable Electrolyte with Polymer/Solid
  - Beware if Li-metal instead of Li-ion
    - Increases energy density, but raises the Fire Risk

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