ENERGY STAR BATTERY CHARGER SYSTEM SPECIFICATION

Review of ENERGY STAR Battery Charger Specification

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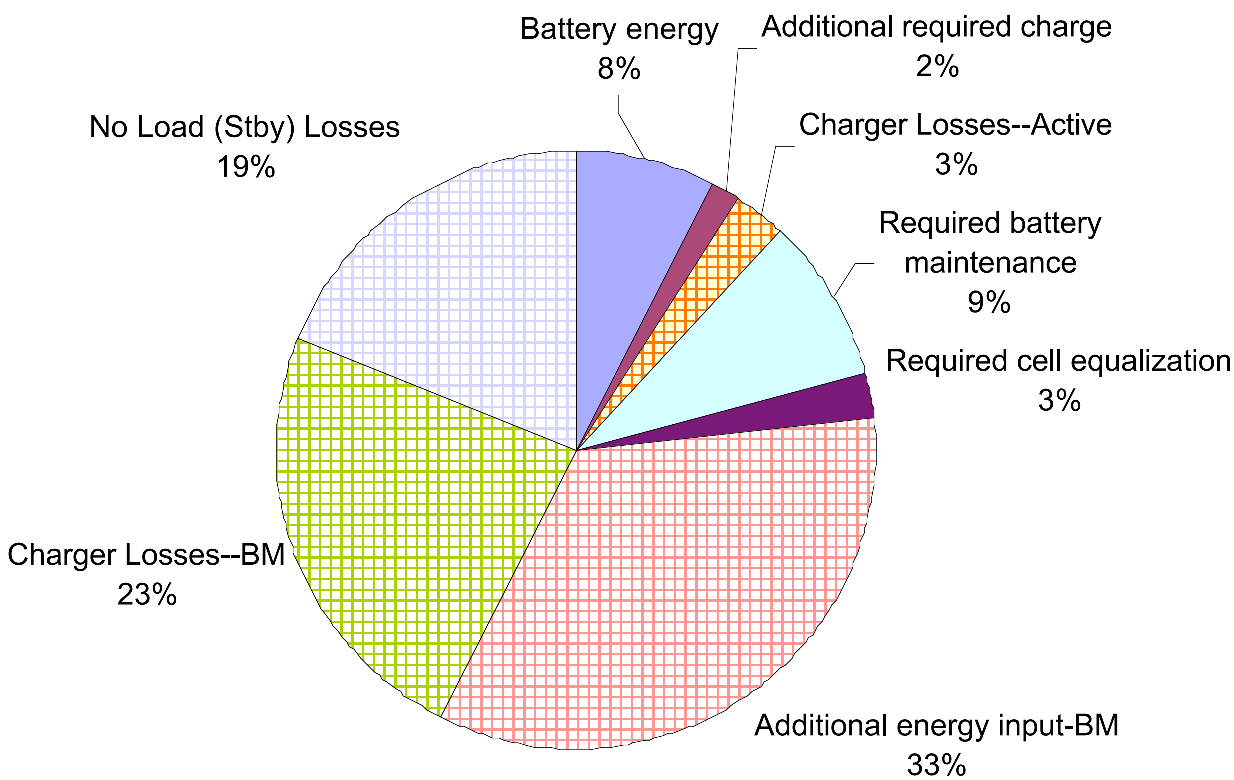
Landscape for BC Specification Development

- EPS specification in place Jan. 2005
- EPS covered a portion of battery charged products including electronics, cell phones
- BC specification to cover remaining products
  - nearly exclusively NiCad, and NmH systems
- Focus on retail, household products
- Products traditionally C&I (forklift batteries, emergency lighting) not addressed
- CW said that smarter chargers (switch mode) were efficient, certainly more efficient than “linear” models

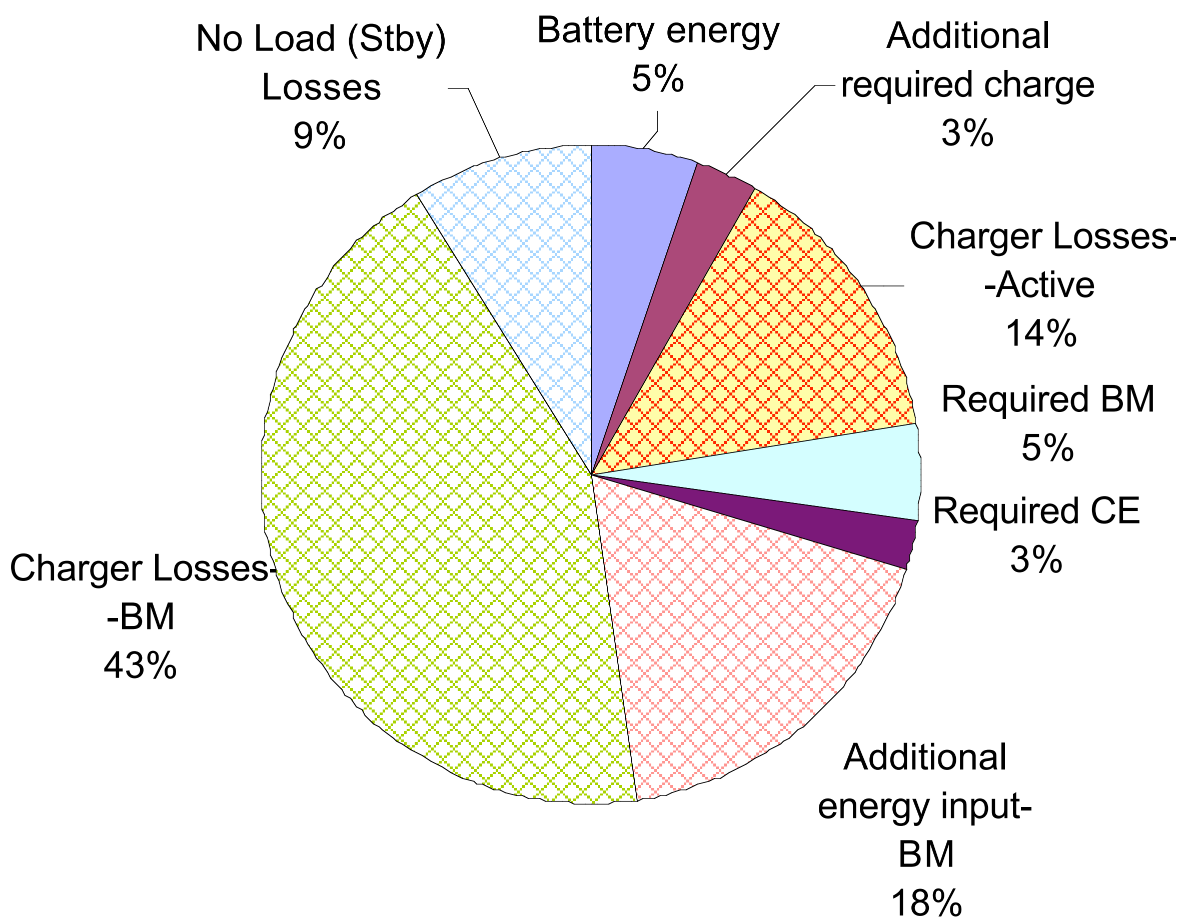
Principles Behind Specification

- Keep specification simple
- Use actual energy consumption of battery chargers
  - User/product scenarios
  - Battery charging (directly useful energy)
  - Additional needed to charge battery (Coulombic efficiency)
  - Cell equalization
  - Self discharge balance, mainly NmH, NiCad (battery maintenance)
  - Losses in power conversion
  - Standby
    - Used in sensing circuits

Battery Maintenance and Standby Dominant for a Fast Charger



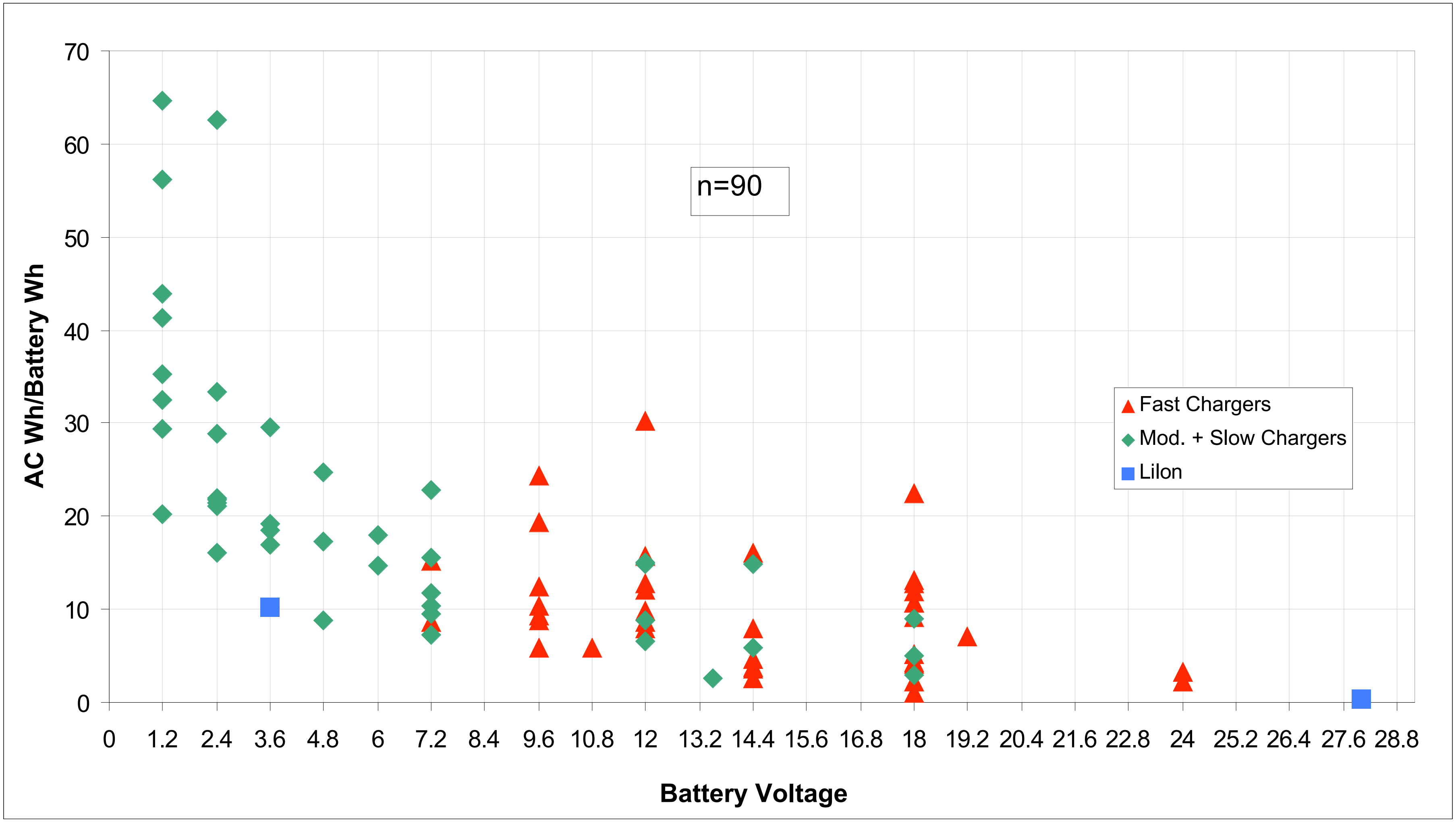
Non-Active Losses Dominant for Slow Chargers as Well



Normalize by Battery Energy

- Energy use a function of battery energy
  - Charging = $(V_{battery} * Ah_{battery})*k$
  - Battery Maintenance = $V_{battery}$ *(C/~30)*time for NmH, NiCad
- Energy in/energy stored plausible metric
- Data show inverse relationship with battery voltage

48-hour "non-active" Energy Use: 90 Products



Observations

- Normalizing by battery energy looks viable
- Normalized energy use inversely proportional to battery voltage
- Large variation in energy use = savings opportunity
- Low voltage products have relatively higher energy use, single cell (1.2 volt) have highest use
- "Fast" chargers have lower energy use, but overlap with "slow" chargers: 1 or 2 specification categories?

  *Fast ~<3.5 hours

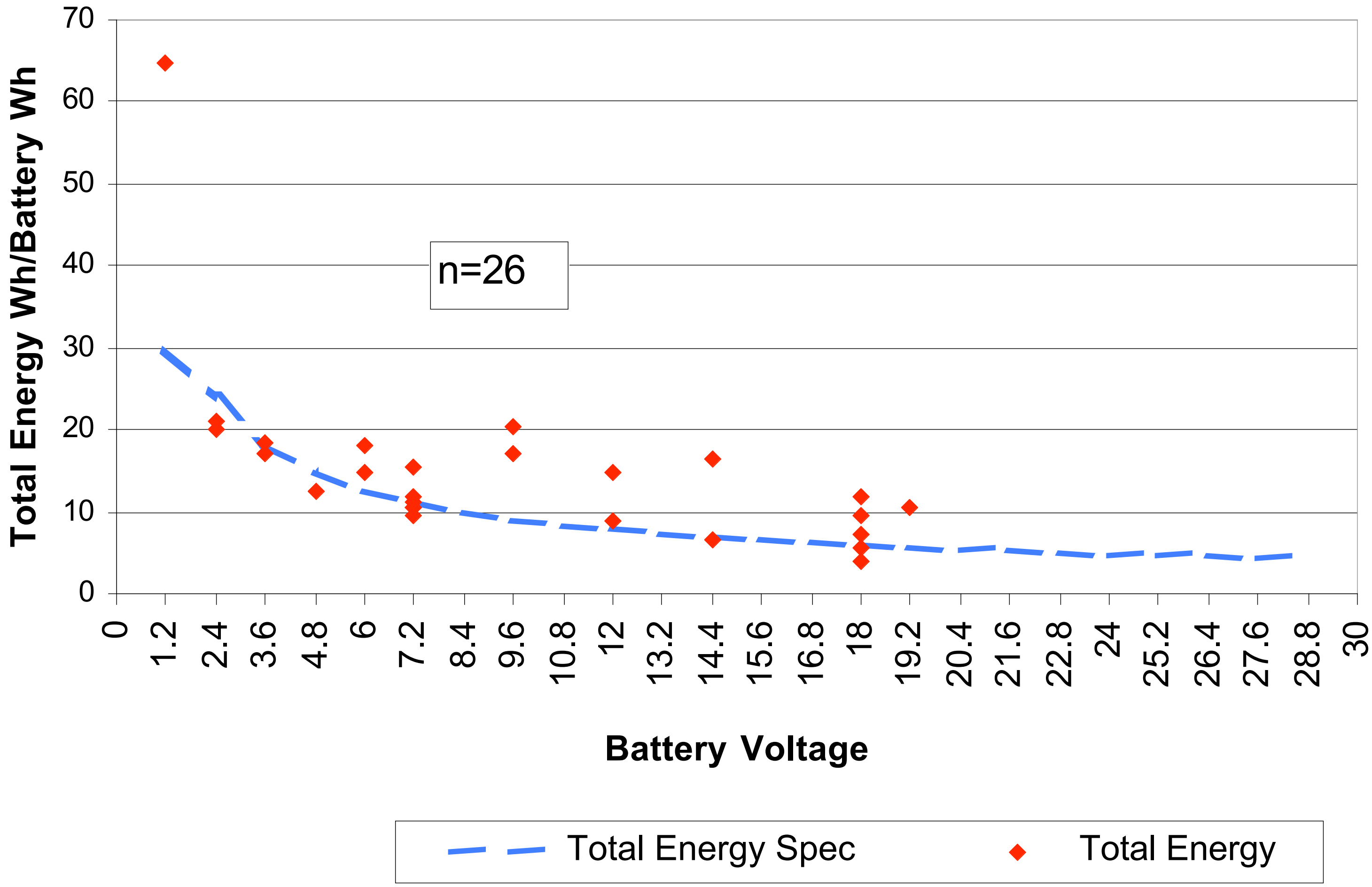
Total Energy vs. Non-Active Energy

Specification Options

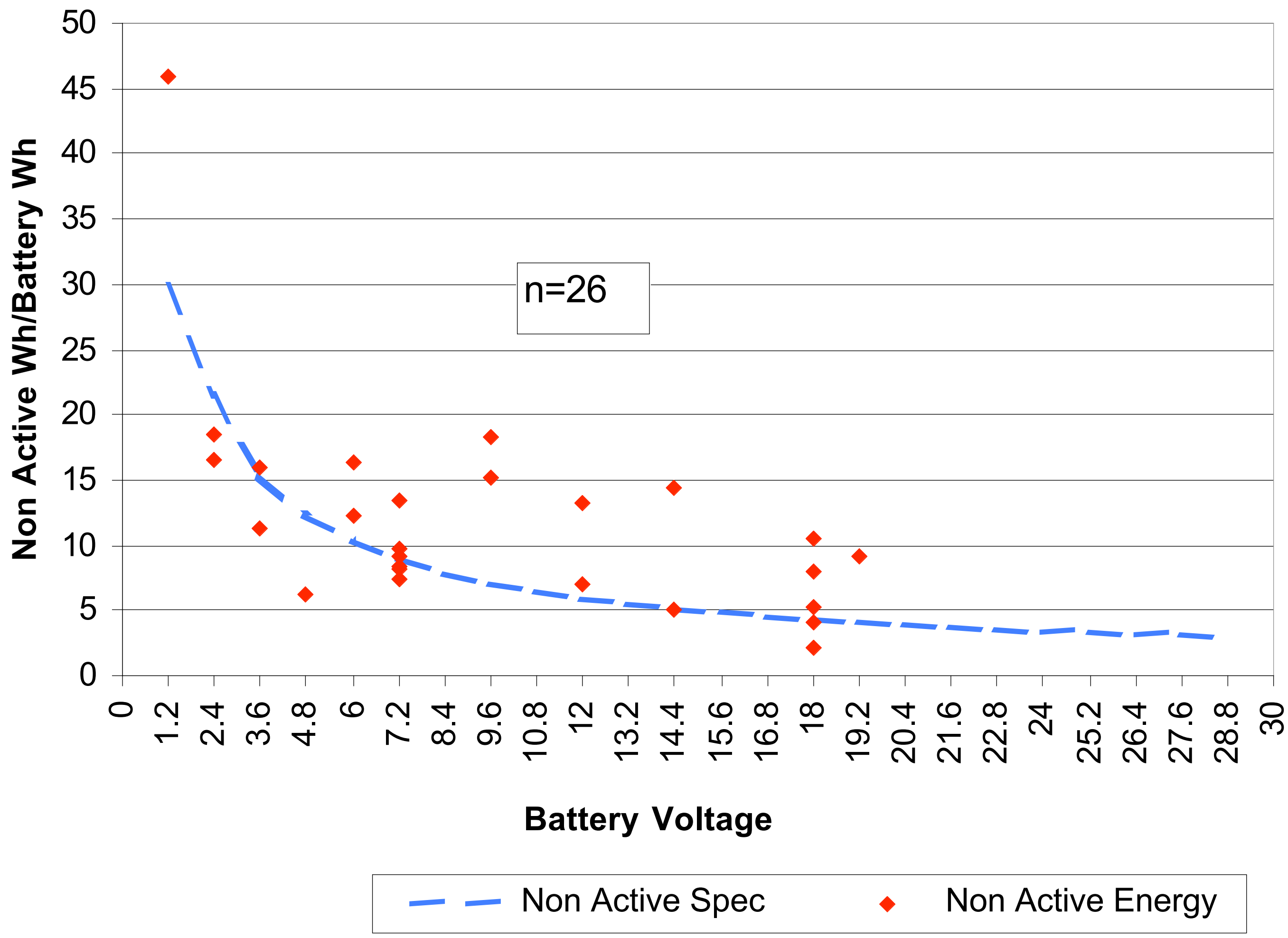
- Option 1: Total energy
  - Captures all energy use
  - Sensitive to use scenario
    - Could require many use scenarios
    - Could invite disagreement
    - Difficult to compare products across categories
  - More sensitive to small errors in measurement of battery capacity

- Option 2: Maintenance and standby only
  - Focuses on lowest efficiency mode, largest savings
    - Battery maintenance important, charging energy usually less important
    - Standby energy use of varying importance
  - Robust, simple test
  - Still focuses on top 25 percent of market
  - Achieves similar savings to Option 1
  - Avoids difficulties of Option 1
  - May miss some additional saving opportunity for some products

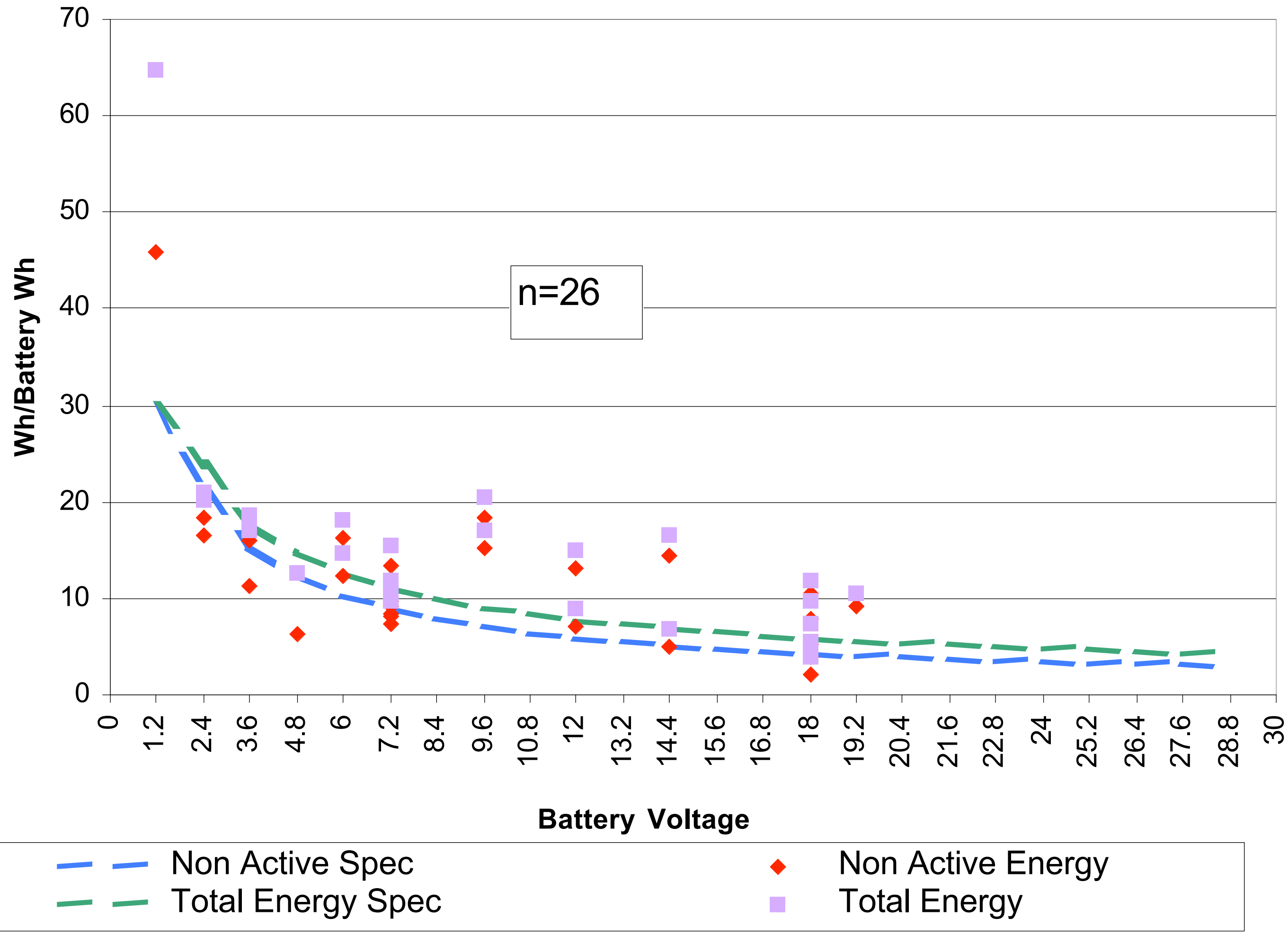
Sample Specification: Total Energy



Sample Specification: Non-Active Energy



Total Energy and Non-Active Energy Overlap



Total and Non-Active Observations

- Approximately equal savings opportunities for products tested (< 3% Difference)
- Same products captured by both specification options
- In either case, a well designed specification can achieve significant energy savings

Why an Averaged Approach vs. Active Efficiency and Standby?

Example: BC Spec More Stringent Than the Title 20 Spec for Product

- 6V Cordless Drill
  - Already meets EPS specification
    - 0.45W No Load
    - 59.8% Active mode efficiency
    - 16 kWh/year
  - If this charger met the proposed BC specification:
    - 11.2 kWh/year

While this product would qualify under the existing Title 20 standard, if the Battery Charger spec were adopted, this product could be driven to reduce energy consumption by an additional 32%.

Integrated Aspect of the BC Specification Can Yield Large Savings

18V Drill #1

- Annual energy consumption:
  - 48.5 kWh
- No load power: 0.88 W
- Reducing no load to EPS spec. yields at most 0.8 kWh

- Same Manufacturer
- Same Battery
- Same Constant Current Charger

18V Drill #2

- Added IC cost effectively controls energy use in BM mode
- Annual energy consumption:
  - 29 kWh
- No load power: 1.88W-increase of 1W, costs 3 kWh per year over EPS specification, but saves 19.5 kWh:
- 40% savings in energy use even including increase in no load power

By specifying overall energy use and not explicitly specifying no load power in the near term, attractive, cost effective energy saving strategies are attainable, in this case yielding 40% savings, even accounting for the increased standby use

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