Draft 1 Version 2.0 Specification for BCSs

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Katharine Kaplan

U.S. Environmental Protection Agency
ENERGY STAR® Program

Matt Malinowski

ICF International

Outline

» 1. **Introduction**
  - **Meeting objectives**
  - **Benefits of ENERGY STAR**
2. Definitions and Scope
3. Test Methods
4. Qualification Criteria
5. Dataset Assembly
6. Next Steps

Introduction: Meeting Objectives

1. Introduce ENERGY STAR to those new to the program.
2. Present rationale for Draft 1 Version 2.0 Specification, distributed on December 7.
3. Solicit comment on Draft 1 Version 2.0 Specification.
4. Present the specification development timeline.

What is ENERGY STAR?

- Joint program of the U.S. EPA and U.S. Department of Energy (DOE)
- Promotes energy-efficient products and practices
- Helps consumers and organizations save money and protect the environment
  - $17 billion saved in 2009
  - Reduced greenhouse gas emissions by equivalent of 30 million cars (2009)
- Influential brand recognized by over 80% of Americans

ENERGY STAR Guiding Principles

- EPA and DOE consider the following criteria when determining whether to develop or revise ENERGY STAR product specifications:
  - Significant energy savings will be realized on a national basis.
  - Product energy consumption and performance can be measured and verified with testing.
  - Product performance will be maintained or enhanced.
  - Purchasers of the product will recover any cost difference within a reasonable time period.
  - Specifications do not unjustly favor any one technology.
  - Labeling will effectively differentiate products to purchasers.

Specification Development Cycle

Additional Resources

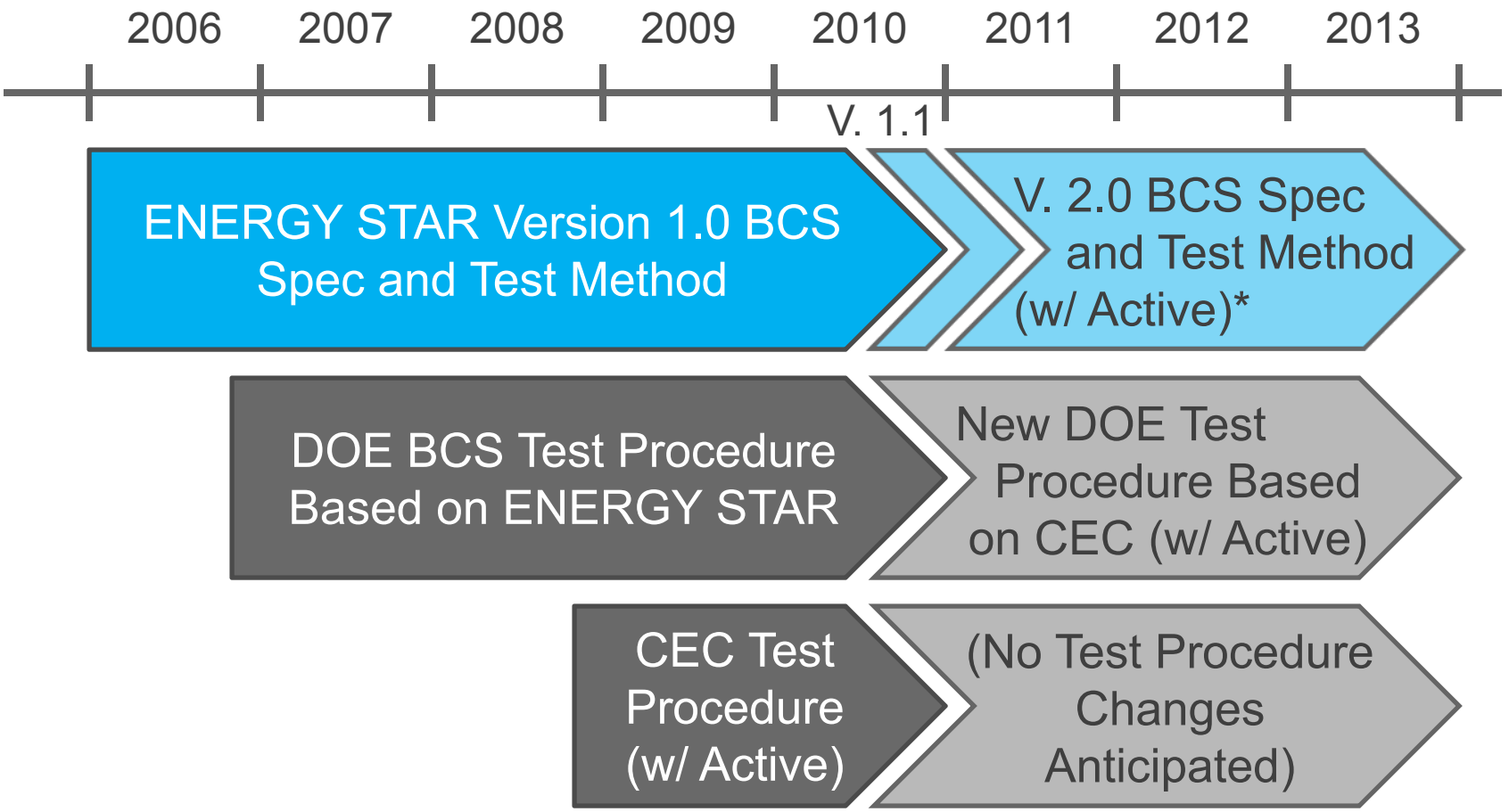
- Please see the ENERGY STAR Partner Resources website for additional information.
- www.energystar.gov/partners

ENERGY STAR for Battery Charging Systems (BCSs)

- Version 1.0 Specification took effect Jan. 2006
  - Complementary to ENERGY STAR external power supply (EPS) specification
  - Limited scope intended to quickly deliver savings

- Revision announced earlier in 2010:
  - Expand scope of products covered
  - Address testing in active/charging mode
  - Work with DOE and other governments
    - Promote harmonization, as feasible

Other BCS Test Procedure Efforts



* ENERGY STAR Version 2.0 specification effective June 2011 for new product types, and March 2012 for currently included product types.

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Definitions

- Most definitions based on proposed DOE test procedure.
  - For consistency with testing.
  - Some modifications for clarity, e.g. “Battery Energy”:

Original DOE	Proposed ENERGY STAR
The energy, in watt-hours, delivered by the battery under the specified discharge conditions in the test procedure.	The energy, in watt-hours, delivered by a Battery under discharge conditions specified in the ENERGY STAR Test Method.

Definitions (cont.)

- Definitions of “Battery Charger” and “Battery Charging System” based on Version 1.0 spec.
  - DOE scope restricted to consumer products.

Battery Charger	A device intended to replenish the charge in a Battery. A Battery Charger connects to the mains at the power input and connects to the Battery at the output. The charger may be comprised of multiple components, in more than one enclosure, and may be fully or partially contained in a Battery-operated End-use Product.
BCS	A combination of a Battery Charger and a Detachable or Integral Battery that is designed to power a Battery-operated End-use Product.

General Scope

- "BCSs using either integral or detachable Batteries for consumer and industrial uses, including handheld tools and appliances, mobile communication devices, and motive equipment."
  - Intended to include the widest practical range of galvanically connected, AC input, DC output BCSs.
  - This scope presents the greatest energy savings opportunity.
  - Includes products within the scope of the original specification.

Additions to the Scope

- Cordless Phones
  - Currently covered by the Telephony specification.
    - Only specifies performance in phone standby mode.
  - Significant savings exist in battery charging mode.
    - EPA is therefore proposing to cover phones under BCS.

Usage Profile

[Hours or Charges Per Day]

Active + Maint.	No Battery	Charges per Day
21.84	2.16	0.71

Per-Unit Energy Consumption (UEC)
[kWh/yr]

	Active + Maint.	No Battery	Charges per Day
Baseline UEC	5.6	4.6	0.3
Potential ENERGY STAR UEC	1.0	2.5	0.1
Potential Savings	**4.6**	**2.2**	**0.2**

Additions to the Scope (cont.)

- Cellular Phones and Handheld Computers
  - EPA is proposing to include battery-charger products formerly covered as End-Use Products Using External Power Supplies.

Additions to the Scope (cont.)

- Notebooks and Netbooks
  - EPA does not intend to include these products as BCSs (currently in ENERGY STAR Computers spec.).

- EPA seeks comment on:
  - Typical usage of portable computing products.
  - Natural divisions between different types of portable computing products.

General Exclusion

- EPA will cover products under only one specification, whether
  - BCS specification, or
  - Specification particular to the product.
- EPA will exclude from BCS products covered under another ENERGY STAR specification.
- EPA is proposing to move these products under the BCS specification:
  - Cordless telephones and combination units, and
  - Handheld computers up to but excluding netbooks.

Specific Exclusions

- EPA proposes to exclude certain BCSs due to limited savings potential.

Type	Examples
BCSs with inductive coupling	• Toothbrush • Charging Pad
BCSs that do not draw power from AC mains	• MP3 Player • In-car GPS Receiver
BCSs for primary-cell chemistries	• Alkaline Charger
BCSs for on-road vehicles	• Electric and Hybrid-Electric Car Charger
BCSs for stationary, backup, or emergency uses	• Solar PV, Emergency Lighting, UPS

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Test Methods

- EPA Proposes to Classify Included BCSs Based on Battery Energy:

Type	Battery Energy, E_B, in Watt-hours	DOE Product Class	Example Product
Small Portable BCSs	$100 < E_B \leq 3{,}000$	2	Cell Phone
		3	Portable DVD
		4	Power Tool
		5	Ride-On Toy
		6	Scooter
BCSs for Golf Cars	$3{,}000 < E_B \leq 10{,}000$	7	Golf Car
BCSs for Industrial Motive Equipment	$E_B > 10{,}000$	N/A	Lift Truck

Test Methods (cont.)

- EPA Proposes to Test According to the Following Test Methods:

Type	Test Method	Metrics
Small Portable BCSs	Proposed DOE Test Method, Appendix Y to 10 CFR Part 430	• 24-hour Active and Maintenance Energy • Maintenance Power • No-battery Power • Off Power • Battery Energy (Disch.)
BCSs for Golf Cars		
BCSs for Industrial Motive Equipment	Part 2 of California Energy Commission Test Procedure	• Charge Return Factor • Conversion Efficiency • Power Factor • Maintenance Power • No-battery Power

Test Conditions

- DOE specifies testing at 115 V.
- EPA proposes the following test conditions:
  - For single-phase and $E_B \leq 10{,}000$ kWh:

Market	Voltage	Frequency
North America, Taiwan	115 Vac	60 Hz
Europe, Australia, New Zealand	230 Vac	50 Hz
Japan	100 Vac	50 Hz/60 Hz

  - For three-phase or $E_B > 10{,}000$ kWh:
    - Same conditions as specified above, or
    - If not intended for operation at above voltages, then at the highest allowable voltage.

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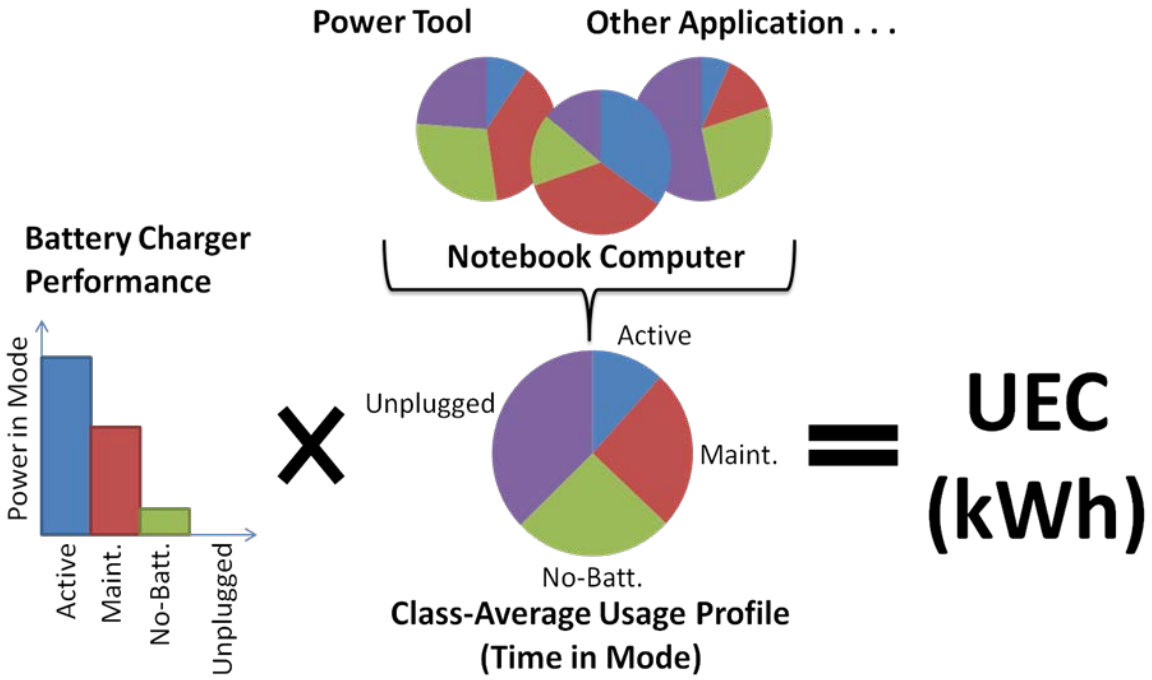
Qualification Criteria for Small Portable BCSs

- Apply to small portable BCSs with battery energy in the range $100 < E_B \leq 3{,}000$ Wh.
- Composed of:
  - Unit-Energy Consumption (UEC) Limits.
  - Specified by DOE Product Class.
  - Supplemented by a Potential Non-Active Power Allowance.

Qualification Criteria for Small Portable BCSs (cont.)

- Product UEC is calculated using:
  - Energy consumption in each mode, measured in the test method.
  - Average usage profiles for each product class, from DOE Preliminary Analysis.



Qualification Criteria for Small Portable BCSs (cont.)

- Usage Profiles (with correction):

DOE Prod. Class	Battery Energy, E_B, as Measured in the Test Method (watt-hours)	Rated Voltage, V_B, (volts)	Active and Maint. Time, t_{AM} (hr/dy)	No-Battery Time, t_{NB} (hr/dy)	Unplugged Time, t_U (hr/dy)	Off Time, t_O (hr/dy)	Number of Charges Per Day, N_C
2	$E_B \leq 100$	$V_B \leq 4$	9.7	5	9.4	0	0.56
3	$E_B \leq 100$	$4 < V_B \leq 10$	5.6	0.2	18.1	0.1	0.22
4	$E_B \leq 100$	$V_B > 10$	~~16.8~~ 16.8	0.3	6.9	0.1	0.88
5	$100 < E_B \leq 3000$	$V_B \leq 20$	7.7	0.5	15.8	0	0.55
6	$100 < E_B \leq 3000$	$V_B > 20$	15.4	8.6	0	0	0.46

Qualification Criteria for Small Portable BCSs (cont.)

- UEC Equation (with correction):

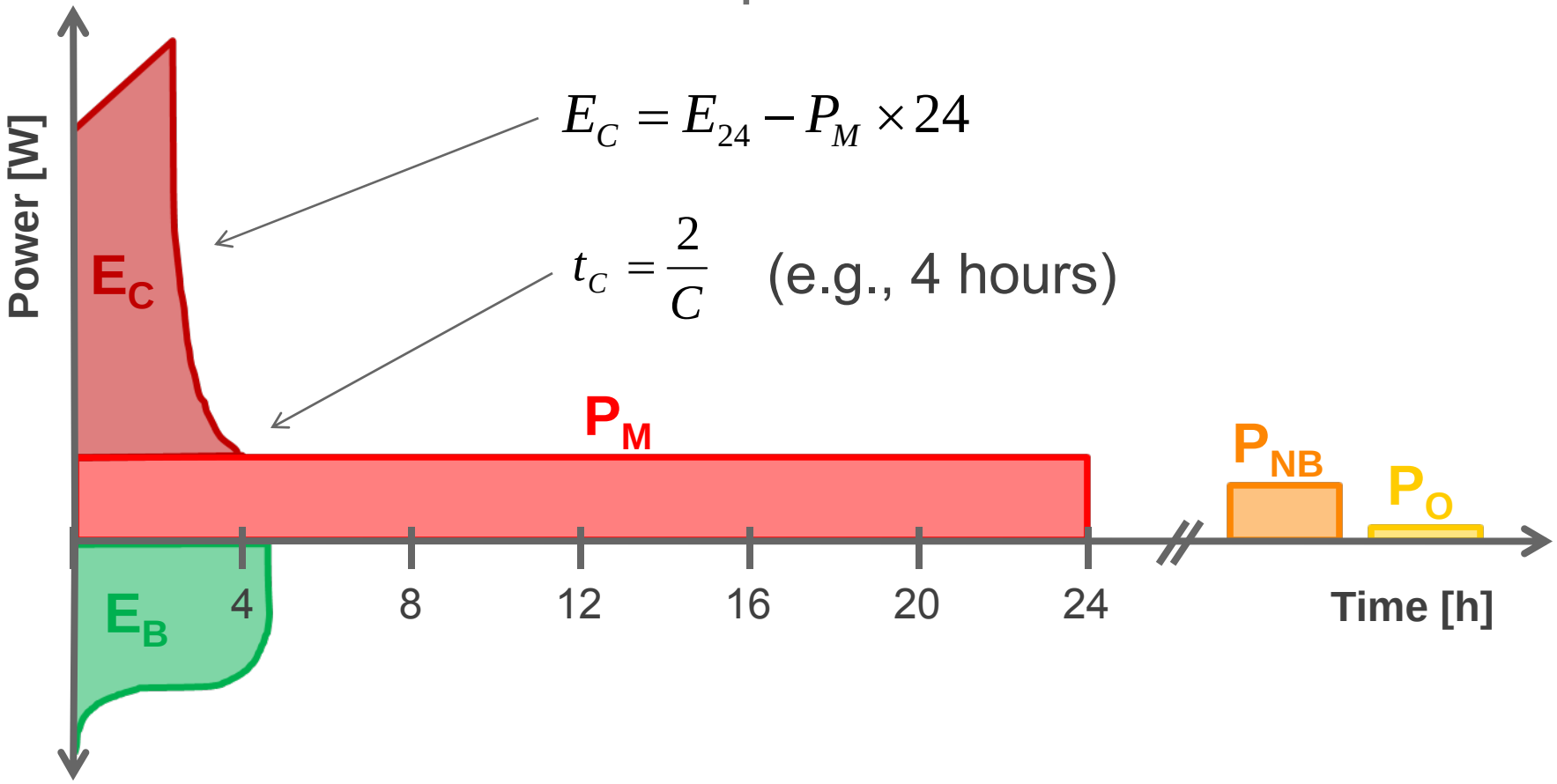
$$UEC = \begin{cases} \frac{365}{1000} \times \left([E_C - E_B] \times N_C + P_M \times [t_{AM} - t_C \times N_C] + P_{NB} \times t_{NB} + P_O \times t_O \right), & t_C \times N_C \le t_{AM} \\ \frac{365}{1000} \times \left([E_C - E_B] \times N_C + P_M \times t_{AM} + P_{NB} \times t_{NB} + P_O \times t_O \right), & t_{AM} < t_C \times N_C \le t_{AM} + t_U \\ \frac{365}{1000} \times \left\{ (E_C - E_B) \times N_C + P_{NB} \times \left(t_{NB} - [t_C \times N_C - t_{AM} - t_U] \right) \right\} + P_O \times t_O, & t_C \times N_C > t_{AM} + t_U \end{cases}$$

$$E_C = E_{24} - P_M \times 24 \qquad t_C = \frac{2}{C}$$

- Illustrative form—may be updated for consistency with DOE methodology.

Qualification Criteria for Small Portable BCSs (cont.)

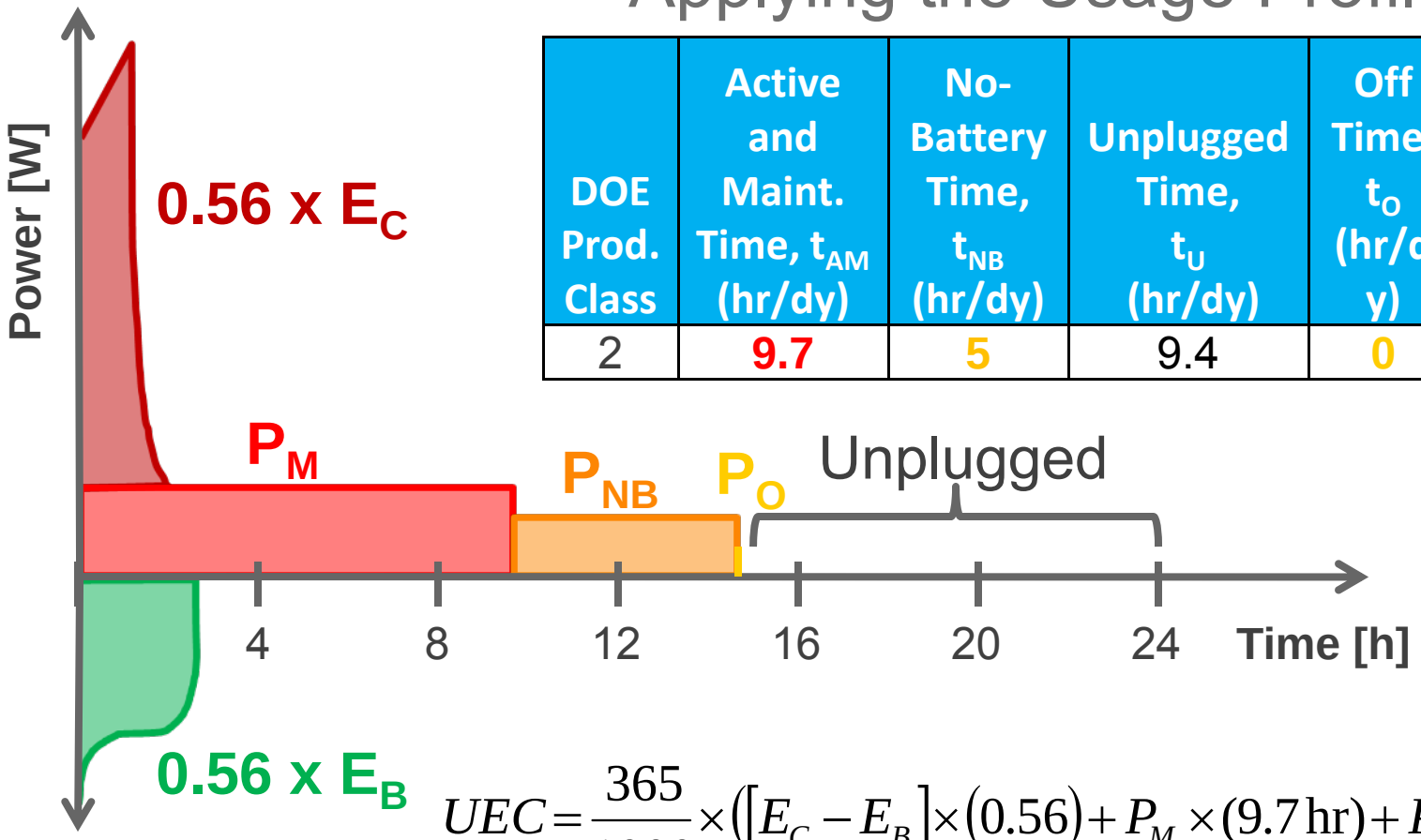
- UEC Calculation Example and Illustration



Qualification Criteria for Small Portable BCSs (cont.)

- Applying the Usage Profile:

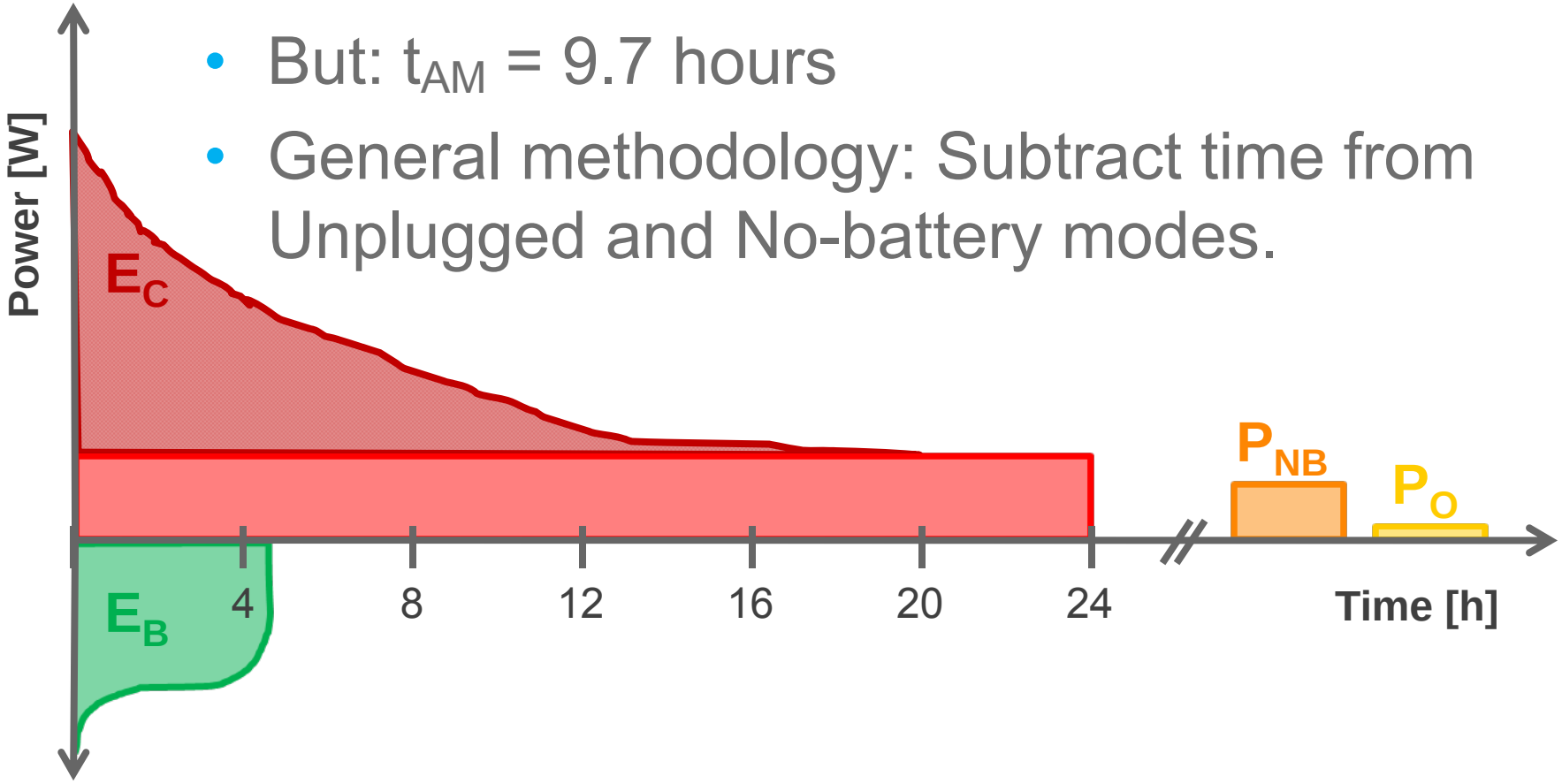
DOE Prod. Class	Active and Maint. Time, t_{AM} (hr/dy)	No-Battery Time, t_{NB} (hr/dy)	Unplugged Time, t_U (hr/dy)	Off Time, t_O (hr/dy)	Chgs. Per Day, N_C
2	9.7	5	9.4	0	0.56



$$UEC = \frac{365}{1000} \times \left(\left[E_C - E_B \right] \times (0.56) + P_M \times (9.7\,\text{hr}) + P_{NB} \times (5\,\text{hr}) \right)$$

When Usage Profile Does Not Allow for Charges

- t_C = 20 hours, N_C = 0.56, t_C x N_C = 12.1 hr
- But: t_{AM} = 9.7 hours
- General methodology: Subtract time from Unplugged and No-battery modes.



Multi-voltage and Multi-port

- Multi-voltage and multi-port chargers can be operated with a variety of batteries.
  - Multi-voltage currently tested with 3 different batteries, including:
    - Min. nominal energy batteries,
    - Max. nominal energy batteries,
    - Specific battery packaged with charger.
  - Multi-port currently tested with maximum number of identical batteries.
- Chargers can be both multi-voltage and multi-port, in which case both requirements apply.

Multi-voltage and Multi-port (cont.)

- DOE proposed table for selecting appropriate batteries for test (may result in additional tests).

Multi-voltage	Multi-port	Multi-capa-city	# of Tests	Battery Selection
No	No	No	1	Any
		Yes	2	• Highest charge capacity • Lowest charge capacity
	Yes	Yes or No	2	• One port, min. number of lowest capacity • All ports, max. number of highest capacity
Yes	No	No	2	• Lowest voltage • Highest voltage
	Yes to Either or Both		3	• One port, lowest voltage and lowest capacity • One port, highest voltage and lowest capacity • All ports, highest capacity

Multi-voltage and Multi-port (cont.)

- Current specification requires averaging results of multi-voltage test and qualifying at the average voltage:

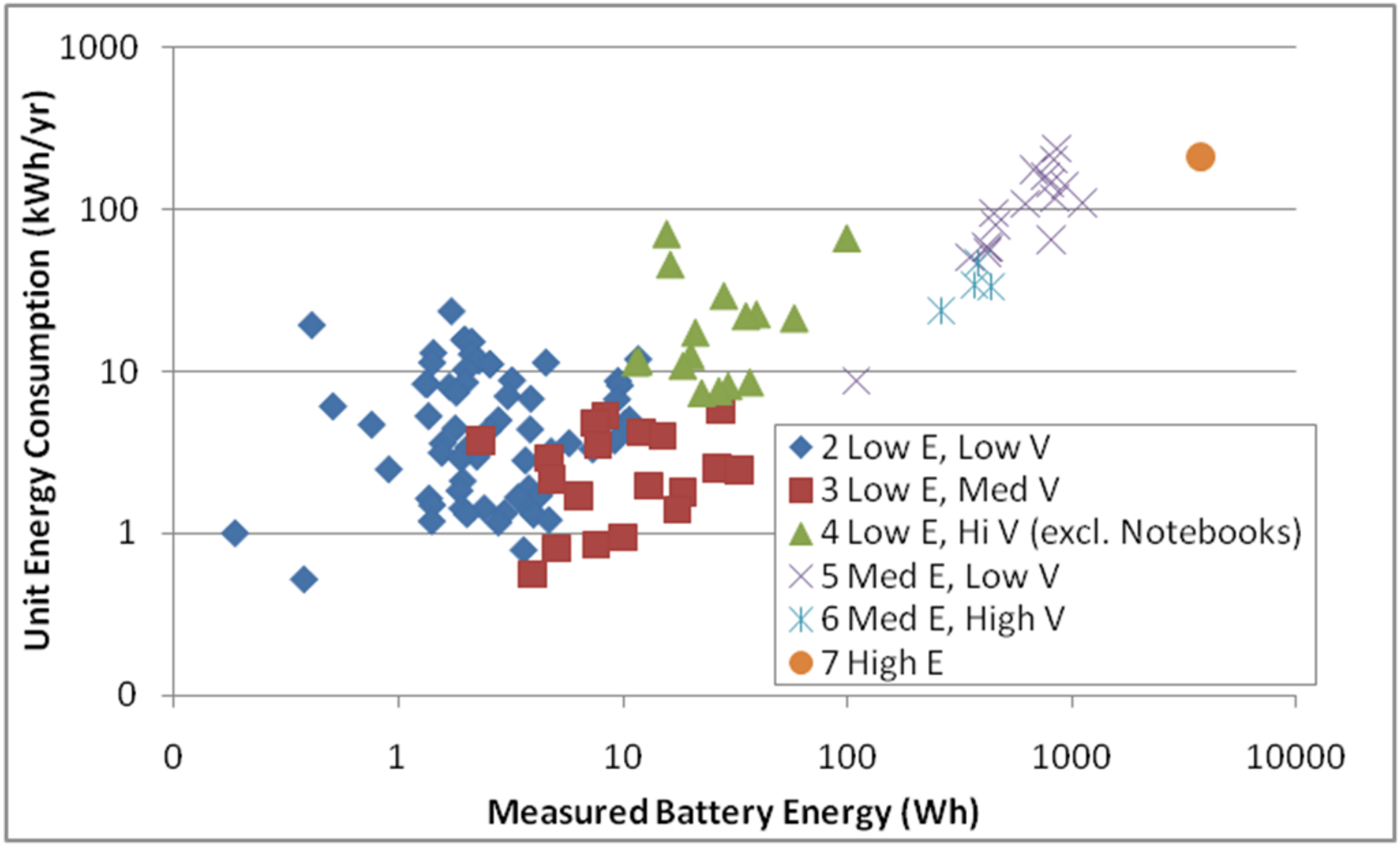
Equation	Energy Ratio Formula	Reference Voltage (V)
1. Normal (Single Battery)	$ER = \frac{\text{Nonactive Energy}}{\text{Battery Energy}}$	$V = V_{Battery}$
2. Multi-Voltage A La Carte	$ER = \frac{\sum \text{Nonactive Energies}}{\sum \text{Battery Energies}}$	$V = V_{Average}$*
3. Multi-Port	$ER = \frac{\text{Nonactive Energy}}{\sum \text{Battery Energies}}$	$V = V_{Single\ Pack}$*

- Alternatives include qualifying at both min. and max. voltage.

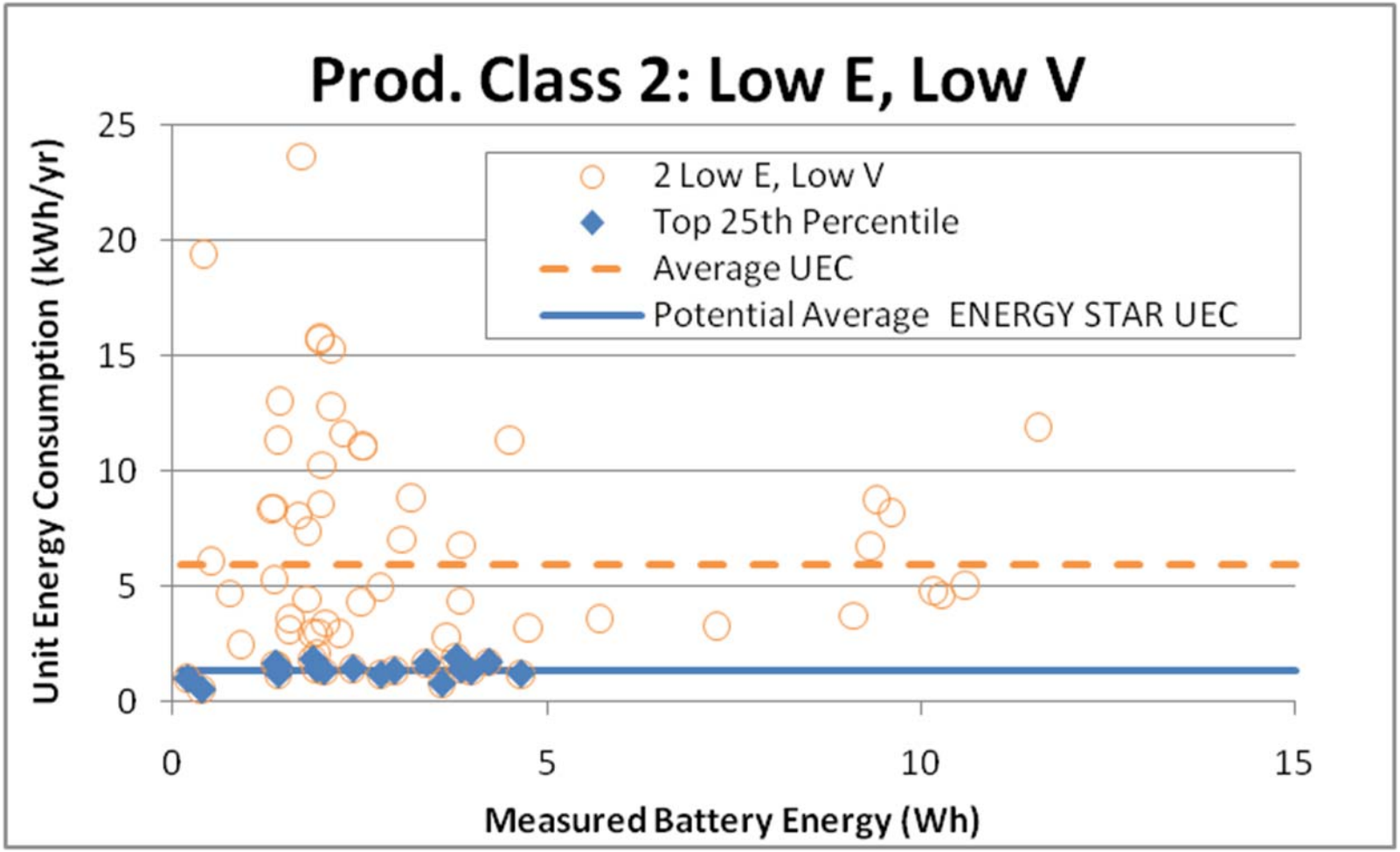
UEC Levels for Small BCSs

DOE Prod. Class	Product Class Description	Battery Energy, E_B, as Measured in the Test Method (watt-hours)	Rated Voltage, V_B, (volts)	UEC_{MAX} (kWh/yr)
2	Low E, Low V	$E_B \leq 100$	$V_B \leq 4$	1.9
3	Low E, Med V	$E_B \leq 100$	$4 < V_B \leq 10$	1.5
4	Low E, High V	$E_B \leq 100$	$V_B > 10$	10.2
5	Med E, Low V	$100 < E_B \leq 3{,}000$	$V_B \leq 20$	58.1
6	Med E, High V	$100 < E_B \leq 3{,}000$	$V_B > 20$	30.8

Data Supporting UEC Levels



Data Supporting UEC Levels (cont.)



UEC Levels for Small BCSs and Anticipated Savings

DOE Prod. Class	Battery Energy, E_B, as Measured in the Test Method (watt-hours)	Rated Voltage, V_B, (volts)	UEC_{MAX} (kWh/yr)	Anticipated Per-Unit Savings (kWh/yr)	Anticipated Total Savings at 50% Market Pen. (kWh/yr)
2	$E_B \leq 100$	$V_B \leq 4$	1.9	4.6	1,534.3
3	$E_B \leq 100$	$4 < V_B \leq 10$	1.5	1.8	101.4
4	$E_B \leq 100$	$V_B > 10$	10.2	14.3	966.5
5	$100 < E_B \leq 3{,}000$	$V_B \leq 20$	58.1	64.0	410.6
6	$100 < E_B \leq 3{,}000$	$V_B > 20$	30.8	10.7	42.6

Nonactive Power Allowance

- EPA is considering an incentive to further promote savings in nonactive (i.e., Maintenance and No-battery) modes.
  - Specified allowance could be added to UEC_{MAX} limit if power in given mode is 0 watts:

Battery Energy, E_B, as Measured in the Test Method (watt-hours)	Allowance If Maintenance Mode Power = 0 watts (kWh/yr)	Allowance If No-battery Mode Power = 0 watts (kWh/yr)
$E_B \leq 100$	0.5	0.5
$100 < E_B \leq 3{,}000$	5	5

Qualification Criteria for Golf Car BCSs

- EPA has received minimal efficiency test data for golf car BCSs.
- EPA will require additional data before proposing qualification criteria for this product type.

Qualification Criteria for Industrial BCSs

- Apply to large industrial BCSs with battery energy in the range E_B > 10,000 Wh.
  - Includes BCSs for lift trucks and other industrial motive equipment.
- Based on Modal Limits:

Mode	Metric
Active	Charge Return Factor (CRF)
	Power Conversion Efficiency
	Power Factor
Maintenance	Maintenance Power
No-battery	No-battery Power

Qualification Criteria for Industrial BCSs (cont.)

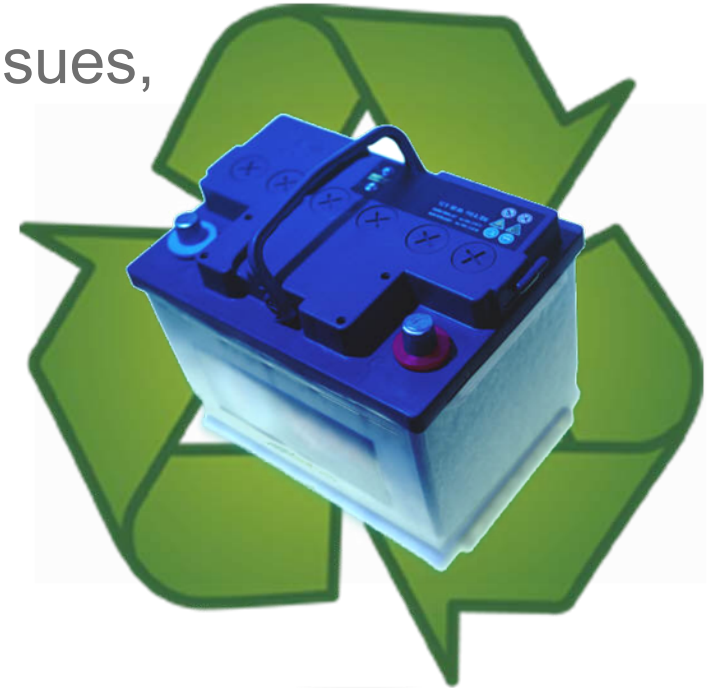
Depth of Discharge	Charge Return Factor Limit
40%	1.05 ≤ CRF ≤ 1.20
80%	1.05 ≤ CRF ≤ 1.15
100%	1.05 ≤ CRF ≤ 1.15

Mode	Metric	Limit
Active	Conversion Efficiency	≥ 0.84
	Power Factor	≥ 0.85
Maintenance	Maintenance Power	≤ 40 watts
No-battery	No-battery Power	≤ 20 watts

- Limits represent the top 20–25% performers in EPA's test dataset.

Additional Environmental Impacts

- EPA is considering accounting for non-use phase environmental impacts.
  - E.g., battery disposal
- EPA welcomes comment on:
  - Battery recycling and lifetime issues,
  - Recycling infrastructure currently in place, and
  - Performance of such infrastructure, especially for lead-acid batteries.



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Provision of Test Data

- Although EPA is proposing qualification limits for some product types, the Agency welcomes further assistance with assembling a larger efficiency dataset for all products.
- In particular:
  - BCSs for golf cars (DOE product class 7).
  - Small consumer BCSs in DOE classes 4, 5, and 6.
- EPA will include in its analysis all test results added to its dataset by **January 15, 2011**.

Data Collection Sheets

- EPA has provided data collection sheets consistent with previous data collection efforts.

Data Collection Sheet for BCSs with battery energy less than or equal to 10 kilowatt-hours

Category	Field Name	Explanation	Data Entry Field
Testing Organization	Testing Organization Name		
	Address		
	Technician		
	Test Serial Number		
General	Manufacturer	The manufacturer whose model was tested.	
	Model Name	The model name (if applicable)	
	Model Number	Battery energy measured during discharge	
	BC Test Finished	The date that all parts of the test were completed.	Incomplete
	Application Type	The intended end-use application of the BC. Categories include: Power tools, Golf cars, Cordless phones, Cell phones, Universal BCs, Hand vacs, Shavers, Wheelchairs, Cameras, etc.	
Observed Battery Characteristics	Battery Chemistry	Battery chemistry, there are a limited number of options for battery chemistry: Li-ion, NiCd, NiMH, Sealed Lead-Acid, Flooded Lead-Acid.	
	Rated Battery Voltage [V]	The nominal voltage of the battery, as specified on the battery packaging or as calculated by the chemistry-specific cell voltage multiplied by the number of cells.	
	Rated Battery Capacity [Ah]	The rated amount of ampere hours (Ah) which can be delivered under specified conditions of temperature, rate of discharge and final battery voltage. An Ah is a measure of the volume of electricity determined by multiplying the number of amps delivered by the time (hours) of delivery.	
	Rated Battery Energy [Wh]	Value calculated by multiplying current capacity and voltage	
	Charger C-Rate [C]	Charger characteristic typically calculated by dividing the initial design charge current [A] by the battery capacity [Ah].	
Discharge Test Data	Discharge Test Finish Date	Discharge test finish date.	
	Start Voltage [V]	Voltage of the battery at the beginning of the Discharge test.	
	End-of-Discharge Voltage	Calculated parameters necessary for performing discharge test.	
	Measured 0.2C Discharge Current [A]	Calculated parameters necessary for performing discharge test.	

Data Collection Sheets (cont.)

- To speed dataset assembly, EPA would appreciate any comments on the data collection sheets in the next week.
- Updated data collection sheets (if necessary) can then be distributed by December 24.

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Timeline

Milestones	Tentative Dates
• Stakeholder conference call	December 2010
• BCS efficiency testing	November 2010 – February 2011
• Finalize test method (in coordination with DOE)	January 2011
• Issue additional Draft specifications • Host conference calls, as needed	February – April 2011
• Issue Final Draft specification	May 2011
• Issue Final specification	June 2011
• Version 2.0 BCS specification takes effect	• June 2011 (golf car, industrial, and previously excluded consumer BCSs) • March 2012 (other consumer BCSs)

Request for Comment

- EPA seeks comment on all aspects of the specification development process.
- Comments due by January 15, 2011.

- Please email to: batterychargers@energystar.gov

Thank You!

Katharine Kaplan
EPA, ENERGY STAR
202-343-9120
Kaplan.Katharine@epamail.epa.gov

Matt Malinowski
ICF International
202-862-2693
mMalinowski@icfi.com