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Logic Model Review and Savings Estimates of Battery Charger Standards in Oregon

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Executive Summary

Purpose:
NEEA contracted with D&R International to evaluate its efforts to provide technical expertise to the Oregon Legislature in its deliberations directed at the establishment of battery charger standards and to determine if the savings estimates NEEA put forth were reliable and credible.

Key Findings:
NEEA was significantly involved in drafting and supporting the energy efficiency standard passed by the Oregon Legislature for battery chargers.
D&R reviewed two studies to assess whether the savings estimates NEEA provided to the Oregon legislature are reliable and credible. NEEA provided the legislature an estimate that cumulative savings would total 225 GWh (209 GWh and 16 GWh for small and large battery chargers, respectively, by 2020) Based on D&R's review, savings are estimated to be between 219 GWh and 230 GWh

Section 1: Introduction

In 2013, Oregon enacted legislation setting new energy efficiency standards for battery chargers,[1] which collect electrical energy for storage in a mobile device's battery to enable the device to function when it is not connected to a power source. Senate Bill 692 (SB 692), which proposed new standards for battery chargers, was introduced to the Senate Environment and Natural Resources Committee in February 2013. It was revised before being passed by the House Energy and Environment Committee in April. The House passed the bill in May, and the Senate passed the revised bill in June. Governor Kitzhaber then signed the bill, making the efficiency standards for battery chargers effective January 1, 2014.

The Oregon energy efficiency standard for battery chargers duplicates the California standard, which went into effect 11 months earlier, on February 1, 2013. Appendix A presents both standards.

The Northwest Energy Efficiency Alliance (NEEA) provided technical expertise and served as an important resource to the Oregon legislature throughout the legislative process for SB 692. NEEA commissioned D&R International, Ltd. to review NEEA's work on SB 692, including the

[1] As defined in the Oregon energy efficiency standard, "battery charger system" means a battery charger coupled with its batteries, including:
(A) Electronic devices with a battery that are normally charged from AC line voltage or DC input voltage through an internal or external power supply and a dedicated battery charger;
(B) The battery and battery charger components of devices that are designed to run on battery power during part or all of their operations;
(C) Dedicated battery systems primarily designed for electrical or emergency backup; and
(D) Devices whose primary function is to charge batteries, along with the batteries the devices are designed to charge, including chargers for power tool batteries and chargers for automotive, AA, AAA, C, D, or nine-volt rechargeable batteries and chargers for batteries used in larger industrial motive equipment and à la carte chargers.

assessment of the battery charger market in Oregon and the energy savings impact of the Oregon standard.

This report has the following objectives:

- Document and assess NEEA's activities with the Oregon legislature in working toward enacting SB 692
- Review the battery charger market assessment provided by the California Energy Commission (CEC)
- Validate NEEA's estimates of the energy savings from the enactment of the battery charger energy efficiency standard

D&R's work included reviewing publicly available information on SB 692 from the Oregon legislature and interviewing expert sources who worked directly with NEEA to explore NEEA's role in the legislative process. D&R collected from NEEA all information provided to the Oregon legislature in support of SB 692, including the following:

- Savings estimates from Charlie Stephens, NEEA's Senior Engineer, Codes and Standards
- Audio recordings of testimony provided to the Oregon legislature
- Documents in the legislature's docket for SB 692

D&R also reviewed the CEC's market characterization and energy savings estimates. The CEC analysis includes national estimates, which are then scaled to California based on its share of households. The savings estimates NEEA provided to the Oregon legislature were based on a CEC study estimating energy savings for battery charger standards. The study provides an assessment of the impacts of enacting efficiency standards in California, the same standards ultimately enacted in Oregon, so D&R began by reviewing this study. D&R reviewed information from the CEC including the following:

- *Codes and Standards Enhancement (CASE) Initiative for PY2010: Title 20 Standards Development* – a report submitted to the CEC in support of formulating an energy efficiency standard for battery chargers
- *Staff Report Staff Analysis of Battery Chargers and Lighting Controls* and *Staff Analysis of Battery Charger Standards, Proposed Efficiency Standards for Battery Chargers and Lighting Controls* and *Codes* – CEC's reports on energy savings potential from enactment of a energy efficiency standard for battery chargers
- Documents in CEC dockets #09-AAER-2 and #11-AAER-2 for battery charger systems and self-contained lighting controls rulemaking, including comments from the Association of Home Appliance Manufacturers (AHAM) criticizing CEC's analysis

D&R reviewed the shipments, product lifetimes, unit energy consumption (UECs), and compliance rates presented in the CEC report to develop estimates of annual electricity savings of full stock turnover and annual electricity savings in 2020. The energy savings of the full stock turnover provided an estimate of maximum cumulative annual savings potential.

Total energy savings of a standard are calculated using the following four factors:

- Shipments – the number of individual units of each product category that uses battery chargers.

- Product lifetimes – the estimated years of life for the products that use battery chargers. This gives an indication of how frequently consumers replace the products and the battery chargers that are used with them.
- Unit energy consumption (UEC) – the calculated annual energy consumption of each battery charger by the type of product with which it works, based on the tested power draw of the product in each usage mode and the amount of time the product is in each mode. Unit energy savings (UES) are calculated by subtracting the consumption of compliant products from that of non-compliant products.
- Compliance rates – the estimated share of available products that comply with the proposed standard.

D&R also conducted a sensitivity analysis of the 2020 annual energy savings estimate to assess the impact of each component of the savings analysis. This included reviewing the variation in results when savings are calculated using different shipments, UES, and compliance rates.

D&R reviewed testimony provided to the legislature by NEEA and others, examined NEEA analyses, and interviewed representatives of Citizens' Utility Board (CUB), Northwest Energy Coalition (NWEC), and the Oregon Department of Energy (ODOE) to gauge NEEA's role in supporting the legislation. Finally, D&R synthesized the information to determine NEEA's influence on SB 692, from first draft to final passage.

Section 2: Market Assessment

2.1 Overview

The efficiency standard enacted in Oregon matches the standard enacted in California and was supported by the market analysis included in *CEC Staff Analysis of Battery Charger Standards, Proposed Efficiency Standards for Battery Chargers and Lighting Controls and Codes.* The California study analyzes the impacts of the legislation in California. The market study within the CEC report provides data on battery chargers sold across the country and scales the national shipments to California.

The CEC's energy efficiency standard rulemaking process began in February 2007, followed by several years of research, analysis, and consultation. The CEC is required to implement an efficiency standard that:

- prescribes minimum efficiency standards and other requirements for battery charger systems;
- reduces the wasteful, uneconomic, inefficient, and unnecessary consumption of energy for appliances that require a significant amount of energy on a statewide basis;
- sets standards that are based on feasible and attainable efficiencies; and
- does not result in any added total costs to the consumer over the design life of the appliances concerned.

In 2012, the CEC enacted a battery charger standard for California, effective February 1, 2013. D&R reviewed *Codes and Standards Enhancement (CASE) Initiative for PY2010: Title 20 Standards Development*, a report supported by California investor-owned utilities and submitted to the CEC to support enactment of a battery charger standard. D&R also reviewed two CEC reports – *Staff Report for Proposed Efficiency Regulations for Battery Chargers and Lighting Controls* and *Staff Report Staff Analysis of Battery Chargers and Lighting Controls* – that analyzed the energy efficiency standard for battery chargers. The CEC and CASE reports provided valuable information for characterizing the market for battery chargers, including shipments, UEC, and rates of compliance with state standards. The CEC study utilized a great deal of the CASE report, and there are only minor differences between the two.

This section discusses the methodologies used by CEC, as well as the assumptions made for the following areas:

- Battery charger classes and categories
- Shipments and stock battery chargers
- Lifetimes and stock accounting
- Unit energy consumption
- Compliance rates

2.2 Efficiency Standard Levels for Battery Charger Classes

CEC grouped battery chargers into two classes, large and small, based on the overall power and energy consumption of the device utilizing the charger. A small battery charger system is defined as one with a rated input power of 2 kW or less.[2] Large battery chargers have a rated input power greater than 2 kW. The battery charger classes apply equally to all battery chemistries. Tables 2-1 and 2-2 present the efficiency standards enacted in California. (Singh 2014).

Table 2-1. California Standard for Small Battery Chargers

Performance Parameter	Standard
Maximum 24 hour charge and maintenance energy (Wh) (E_b = capacity of all batteries in ports and N = number of charger ports)	For E_b of 2.5 Wh or less: $16 \times N$
	For E_b greater than 2.5 Wh and less than or equal to 100 Wh: $12 \text{ x } N + 1.6 E_b$
	For E_b greater than 100 Wh and less than or equal to 1000 Wh: $22 \text{ x } N + 1.5 E_b$
	For E_b greater than 1000 Wh: $36.4 \text{ x } N + 1.486 E_b$
Maintenance Mode Power and No Battery Mode Power (W) (E_b = capacity of all batteries in ports and N = number of charger ports)	The sum of maintenance mode power and no battery mode power must be less than or equal to: $1\text{x } N + 0.0021\text{x}E_b$ Watts

Notes: 2014 Appliance Efficiency Regulations. California Energy Commission. Publication Number: CEC-400-2014-009-CMF. Retrieved from http://www.energy.ca.gov/2014publications/CEC-400-2014-009/CEC-400-2014-009-CMF.pdf

As noted in the CEC report, "The proposed regulations for small battery chargers are similar to those for large battery chargers. The power consumption limits are lower because of the smaller capacity of the chargers and batteries involved. In addition, the charge mode and maintenance mode of small battery chargers are measured together over a 24-hour period rather than separately as is measured for large battery chargers." (Singh, H. and Rider, K. 2011a, p. 24)

[2] Golf carts are included in the small battery charger class, though they have input greater than 2 kW.

Table 2-2. California Standard for Large Battery Chargers

Performance Parameter		Standard
Charge Return Factor (CRF)	100 percent, 80 percent Depth of discharge	CRF≤ 1.10
	40 percent Depth of discharge	CRF ≤ 1.15
Power Conversion Efficiency		Greater than or equal to: 89 percent
Power Factor		Greater than or equal to: 0.90
Maintenance Mode Power (E_b = battery capacity of tested battery)		Less than or equal to: 10 + 0.0012E_b W
No Battery Mode Power		Less than or equal to: 10 W

Notes: 2014 Appliance Efficiency Regulations. California Energy Commission. Publication Number: CEC-400-2014-009-CMF. Retrieved from http://www.energy.ca.gov/2014publications/CEC-400-2014-009/CEC-400-2014-009-CMF.pdf

2.3 Product Categories Containing Battery Chargers

Products with small and large battery chargers were used to estimate the total stock of battery chargers and energy savings potential. The CEC report assigned products to general product categories; it does not include a technical rationale for the product categories. (Note that the laptop product category applies specifically to laptops and does not include notebook or tablet computers.)

The Federal Regulations and Test Method subsection of the Regulatory Approaches section in the *CEC Staff Analysis of Battery Charger Standards, Proposed Efficiency Standards for Battery Chargers and Lighting Controls* presents the only explanation of how CEC categorized the products evaluated for its report. CEC proposed taking the regulatory approach outlined in the CASE report, rather than the approach outlined by DOE. According to the CEC report, "Energy Commission staff have analyzed the approach proposed in the CASE report and evaluated the cost effectiveness and feasibility of implementing the regulation in California. Staff also determined that the fundamentally different approach outlined in DOE's TSD [Technical Support Documents for *Energy Conservation Program: Energy Conservation Standards for Battery Chargers and External Power Supplies*] would lead to less energy savings in California than the [sic] proposed in this report." (Singh, H. and Rider, K. 2011a, p. 23)

The savings analysis provided by the CEC uses the product categories identified in the CASE report. These include the following:

- Auto/marine/RV
- Cell phones
- Cordless phones
- Personal audio electronics
- Emergency systems
- Laptops
- Personal care
- Personal electric vehicles
- Portable electronics
- Portable lighting
- Power tools
- Universal battery chargers
- Golf carts/electric carts
- Emergency backup lighting
- Handheld barcode scanners
- Two-way radios
- Single phase lift-trucks
- Three phase lift-trucks

2.4 Shipments and Stock of Battery Chargers

CEC used national shipment data by product category gathered from industry and stakeholder groups. National data was scaled to California based on the percentage of California households in the nation, presented in Table 2-3.

Table 2-3. 2009 National Shipments of Small Battery Chargers

Product Category	**Shipments (Units)**
Auto/Marine/RV	1,714,286
Cell Phones	269,238,095
Cordless Phones	30,571,429
Personal Audio Electronics	100,190,476
Emergency Systems	24,761,905
Laptops	43,523,810
Personal Care Equipment	17,523,810
Personal Electric Vehicles	380,952
Portable Electronics	19,047,619
Portable Lighting	95,238
Power Tools	27,333,333
Universal Battery Chargers	1,047,619
Golf Carts	161,905
Emergency Backup Lighting	714,286
Handheld Barcode Scanners	7,428,571
Two-Way Radios	2,857,143
Single Phase Lift-Trucks	47,619
Three Phase Lift-Trucks	19,048
Total	**546,657,143**

Notes: *Codes and Standards Enhancement (CASE) Initiative: Analysis of Standards Options for Battery Charger Systems.* Version: BCS CASE Report Version 2.2.2. California Public Utilities Commission. Retrieved from http://www.energy.ca.gov/appliances/battery_chargers/documents/2010-10-11_workshop/2010-10-11_Battery_Charger_Title_20_CASE_Report_v2-2-2.pdf.

Battery chargers are found in the market bundled with the products that need them at a ratio of one battery charger per product. This study assumes that battery chargers are shipped along with products that require them on a one-to-one basis, making sales of products that require a battery charger a proxy for battery charger shipments. Universal battery chargers are tracked separately.

CEC applied growth rates from the CASE report to estimate future shipments based on 2009 sales data. CEC estimated shipments to California by scaling the national shipment figures to California's share of national households, 10.5%.

CEC uses the compound annual growth rates (CAGRs) presented in the CASE report to estimate 2013 shipments based on 2009 shipments. However, CEC has not disclosed how Ecova determined the CAGRs. Table 2-4 presents 2009 and 2013 sales of products bundled with battery chargers and their growth rates for each product category in California. The 2010 CAGRs are estimates of shipment growth between 2009 and 2010; the 2013 CAGRs are estimates of shipment growth from 2011 to 2012. In general, shipments grew more from 2010 to 2011 than from 2012 to 2013. Sales figures for 2013 in California were calculated using the following formula:

$$Sales_{2013} = Sales_{2009} \ X \ (1+CAGR_{2010})^2 \ X \ (1+CAGR_{2013})^2$$

Table 2-4. Battery Charger Shipments in California

Product Category	**Sales 2009 (Units)**	**CAGR 2010**	**CAGR 2013**	**Sales 2013 (Units)**
Auto/Marine/RV	180,000	3%	3%	203,000
Cell Phones	28,270,000	19%	2%	41,650,000
Cordless Phones	3,210,000	-10%	-9%	2,153,000
Personal Audio Electronics	10,520,000	12%	2%	13,729,000
Emergency Systems	1,300,000	0%	0%	1,300,000
Laptops	4,570,000	29%	12%	9,540,000
Personal Care Equipment	1,840,000	4%	3%	2,111,000
Personal Electric Vehicles	40,000	18%	24%	86,000
Portable Electronics	2,000,000	9%	18%	3,309,000
Portable Lighting	110,000	1%	1%	114,000
Power Tools	2,870,000	5%	5%	3,489,000
Universal Battery Chargers	110,000	3%	3%	124,000
Golf Carts/Electric Carts	20,000	16%	11%	33,000
Emergency Backup Lighting	2,000,0000	0%	0%	2,000,000
Handheld Barcode Scanners	20,000	6%	7%	26,000
Two-Way Radios	70,000	0%	0%	70,000
Single Phase Lift-Trucks	2,000	7%	1%	2,000
Three Phase Lift-Trucks	5,000	7%	1%	6,000
Total	**57,137,000**			**79,945,000**

Notes: Staff Report for Proposed Efficiency Regulations for Battery Chargers and Lighting Controls. CEC-400-2011-001-SD. Retrieved from http://www.energy.ca.gov/2011publications/CEC-400-2011-001/CEC-400-2011-001-SD.PDF and http://www.energy.ca.gov/2011publications/CEC-400-2011-001/BCS_Model.xls

D&R scaled shipments to Oregon by multiplying them by the ratio of Oregon households to California households (12.1%). This is estimated from the 2010 Census, which provides counts of households in California and Oregon. Table 2-5 presents estimated 2013 battery charger shipments to Oregon.

Table 2-5. Battery Chargers Shipments in Oregon

Products	Sales 2009 (Units)	Sales 2013 (Units)
Auto/Marine/RV	21,700	24,500
Cell Phones	3,414,100	5,029,900
Cordless Phones	387,700	260,000
Personal Audio Electronics	1,270,500	1,658,000
Emergency Systems	157,000	157,000
Laptops	551,900	1,152,100
Personal Care Equipment	222,200	254,900
Personal Electric Vehicles	4,800	10,400
Portable Electronics	241,500	399,600
Portable Lighting	13,300	13,800
Power Tools	346,600	421,400
Universal Battery Chargers	13,300	15,000
Golf carts	2,400	4,000
Emergency Backup Lighting	241,500	241,500
Handheld Barcode Scanners	2,400	3,100
Two-Way Radios	8,500	8,500
Single Phase Lift-Trucks	200	200
Three Phase Lift-Trucks	600	700
Total	**6,900,200**	**9,654,600**

2.5 Lifetimes and Stock Accounting

CEC uses product category lifetime as a proxy for battery charger lifetime. The replacement analysis uses lifetimes to estimate the stock of battery chargers, by product category. Table 2-6 shows the lifetimes provided by the CEC (Singh, H. and Rider, K. 2011a, p. 34).

D&R reviewed CEC's analysis to examine the 2009 and 2013 stocks of battery chargers. The stock beyond 2009 is used to estimate energy savings potential.

Table 2-6. Product Lifetime

Battery Charger Category	**Lifetime (years)**
Auto/Marine/RV	10
Cell Phones	2
Cordless Phones	5
Personal Audio Electronics	3
Emergency Systems	7
Laptops	4
Personal Care Equipment	5
Personal Electric Vehicles	9.7
Portable Electronics	5.2
Portable Lighting	10
Power Tools	6.5
Universal Battery Chargers	8
Golf Carts/Electric Carts	10
Emergency Backup Lighting	10
Handheld Barcode Scanners	8
Two-Way Radios	8
Single Phase Lift-Trucks	15
Three Phase Lift-Trucks	15

Notes: Staff Report Staff Analysis of Battery Chargers and Lighting Controls. 2011 California Energy Commission. CEC-400-2011-001-SF. Retrieved from http://www.energy.ca.gov/2011publications/CEC-400-2011-001/CEC-400-2011-001-SF.pdf

2.6 Unit Energy Consumption

The UEC of a battery charger is a calculated value based on the tested power draw in each mode of operation and the hours per year a typical consumer would use the product in each mode. Appendix B provides the procedure used for calculating unit energy consumption. The equation to calculate the annual UEC is as follows:

$$UEC = Power_{active} \times frequency_{active} + Power_{maintenance} \times frequency_{maintenance} + Power_{no\ battery} \times frequency_{no\ battery}$$

Energy consumption by the battery charger does not occur when the product is in the Off mode and is unnecessary for calculating the UEC. The time in Off mode is used to provide an estimate of when the product is not connected to a battery charger and/or being utilized by consumers.

The CASE report presents results from testing products to measure their power draws in active mode, maintenance mode, and no battery mode. Ecos Consulting conducted this testing from 2004 to 2008. The CEC largely accepted the results in CASE report, making only minor adjustments in its report (Singh 2011b). Table 2-7 shows the power draws for each product category from CEC.

Table 2-7. Baseline Power Draws of Battery Chargers, by Product Category

Product Category	Power Draw (W)		
	Active	Maintenance	No Battery
Auto/Marine/RV	214	41.9	49.3
Cell Phones	3.9	0.5	0.3
Cordless Phones	2.7	2.2	1.7
Personal Audio Electronics	2.1	0.5	0.1
Emergency Systems	7.0	2.9	2.5
Laptops	27.1	3	1.9
Personal Care	1.2	1	0.9
Personal Electric Vehicles	230	34.1	33.9
Portable Electronics	9.2	2.5	0.9
Portable Lighting	1.8	1.6	0.4
Power Tools	17.5	3.5	1.8
Universal Battery Chargers	7.1	1.1	0.9
Golf Carts	600	103	1.6
Emergency Backup Lighting	2.2	1.6	1.6
Handheld Barcode Scanners	11.2	3	0.2
Two-Way Radios	5.3	2	0.9
Single Phase Lift-Trucks	2000	50	50
Three Phase Lift-Trucks	5600	88.5	33.5

Notes: Staff Report Staff Analysis of Battery Chargers and Lighting Controls. 2011 California Energy Commission. CEC-400-2011-001-SF. Retrieved from http://www.energy.ca.gov/2011publications/CEC-400-2011-001/CEC-400-2011-001-SF.pdf

Table 2-8 shows the maximum power draw allowed under the efficiency standard in each mode.

Table 2-8. Compliant Power Draws of Battery Chargers, by Product Category

Product Category	Power Draw (W)		
	Active	Maintenance	No Battery
Auto/Marine/RV	118.1	0.5	0.3
Cell Phones	2.8	0.5	0.3
Cordless Phones	1.1	0.5	0.3
Personal Audio Electronics	1.2	0.5	0.1
Emergency Systems	4.0	0.5	0.3
Laptops	24.6	0.5	0.3
Personal Care	0.6	0.5	0.3
Personal Electric Vehicles	120	0.5	0.3
Portable Electronics	8.4	0.5	0.3
Portable Lighting	0.7	0.5	0.3
Power Tools	14.7	0.5	0.3
Universal Battery Chargers	3.9	0.5	0.3
Golf Carts	485.7	0.5	0.3
Emergency Backup Lighting	1.0	0.5	0.3
Handheld Barcode Scanners	3.2	0.5	0.2
Two-Way Radios	3.8	0.5	0.3
Single Phase Lift-Trucks	1770.0	10	10
Three Phase Lift-Trucks	5111.0	10	10

Notes: Staff Report Staff Analysis of Battery Chargers and Lighting Controls. 2011 California Energy Commission, CEC-400-2011-001-SF. Retrieved from http://www.energy.ca.gov/2011publications/CEC-400-2011-001/CEC-400-2011-001-SF.pdf. BCS model data. Retrieved from http://www.energy.ca.gov/2011publications/CEC-400-2011-001/BCS_Model.xls.

Table 2-9 provides the share of time spent in each mode used to calculate UECs.

Table 2-9. Operational Mode Assumptions

Product Categories	**Percentage of Hours per Year in Each Mode**			
	Active	**Maintenance**	**No Battery**	**Off**
Auto/Marine/RV	1%	42%	46%	10%
Cell Phones	3%	30%	19%	48%
Cordless Phones	35%	56%	9%	0%
Personal Audio Electronics	2%	25%	35%	38%
Emergency Systems	0%	100%	0%	0%
Laptops	4%	56%	30%	10%
Personal Care	3%	86%	3%	9%
Personal Electric Vehicles	36%	28%	35%	1%
Portable Electronics	1%	11%	1%	87%
Portable Lighting	1%	99%	0%	0%
Power Tools	2%	48%	13%	37%
Universal Battery Chargers	0%	66%	17%	17%
Golf Carts	20%	47%	13%	19%
Emergency Backup Lighting	0%	99%	0%	0%
Handheld Barcode Scanners	13%	52%	35%	0%
Two-Way Radios	19%	31%	50%	0%
Single Phase Lift-Trucks	45%	32%	24%	0%
Three Phase Lift-Trucks	98%	0%	2%	0%

Notes: Staff Report Staff Analysis of Battery Chargers and Lighting Controls. 2011 California Energy Commission, CEC-400-2011-001-SF. Retrieved from http://www.energy.ca.gov/2011publications/CEC-400-2011-001/CEC-400-2011-001-SF.pdf. BCS model data. Retrieved from http://www.energy.ca.gov/2011publications/CEC-400-2011-001/BCS_Model.xls. Please note that because of rounding, some categories do not sum to 100%.

Table 2-10 shows the UECs calculated for baseline and compliant product categories. Unit energy savings (UES) represents the difference between baseline and compliant UEC for each product category.

Table 2-10. Baseline and Compliant Unit Energy Consumption (kWh/yr)

Product Category	Baseline	Compliant	UES
Auto/Marine/RV	349.7	33.28	316.41
Cell Phones	3.48	3.01	0.47
Cordless Phones	19.46	6.17	13.31
Personal Audio Equipment	2.50	2.03	0.47
Emergency Systems	25.38	9.49	15.89
Laptops	33.52	16.71	16.81
Personal Care Equipment	4.15	2.31	1.84
Personal Electric Vehicles	931.17	394.33	536.84
Portable Electronics	3.07	1.33	1.74
Portable Lighting	13.98	5.33	8.65
Power Tools	23.35	8.41	14.94
Universal Battery Chargers	8.16	4.23	3.93
Golf Carts	2,439.95	1,632.21	807.73
Emergency Backup Lighting	13.99	5.43	8.56
Handheld Barcode Scanners	26.59	6.91	19.68
Two-Way Radios	18.09	9.22	8.87
Single Phase Lift-Trucks	8,169.00	7,136.53	1032.64
Three Phase Lift-Trucks	48,038.00	43,839.52	4198.51

2.7 Compliance Rates

Compliance rates are an estimate of the percentage of products that meet the proposed efficiency standard. CEC used the compliance rates presented in the CASE report, which were based on estimates from lab data and qualitative research trends uncovered through market research. It is unclear how CEC determined the values. CEC uses the compliance rates interchangeably as the estimate of compliance rates of 2009 stock and 2010 sales of products bundled with battery chargers.

CEC assigned battery chargers to one of four compliance categories, by product category; the compliance rate provides a way to calculate potential savings from the standard.

- Mostly compliant: 90% (approximately 90% of battery chargers meet the proposed standard)
- Somewhat compliant: 50% (approximately 50% of battery chargers meet the proposed standard)
- Rarely compliant: 10% (approximately 10% of battery chargers meet the proposed standard)
- Not compliant: 0% (few, if any battery chargers meet the proposed standard)

Table 2-11 shows battery charger product categories and estimated compliance rates.

Table 2-11. Compliance Rates

Product Category	Compliance Rate
Auto/Marine/RV	0%
Cell Phones	90%
Cordless Phones	0%
Personal Audio Equipment	90%
Emergency Systems	10%
Laptops	10%
Personal Care Equipment	0%
Personal Electric Vehicles	10%
Portable Electronics	10%
Portable Lighting	0%
Power Tools	10%
Universal Battery Chargers	50%
Golf Carts	50%
Emergency Backup Lighting	50%
Handheld Barcode Scanners	50%
Two-Way Radios	50%
Single Phase Lift-Trucks	0%
Three Phase Lift-Trucks	0%

Notes: Staff Report Staff Analysis of Battery Chargers and Lighting Controls. 2011 California Energy Commission, CEC-400-2011-001-SF. Retrieved from http://www.energy.ca.gov/2011publications/CEC-400-2011-001/CEC-400-2011-001-SF.pdf. BCS model data. Retrieved from http://www.energy.ca.gov/2011publications/CEC-400-2011-001/BCS_Model.xls.

2.8 Market Characterization Conclusion

The CEC and CASE reports provide an assessment of the energy savings for battery chargers used in California. These reports use national data that can also be used to calculate the savings potential in other states, including Oregon.

Battery Classes, Product Categories, and Shipments

The efficiency standard enacted in California covers large and small battery classes. The CEC and CASE reports use the same classifications. Small battery chargers have a rated input power of 2 kW or less; large battery chargers have a rated input power greater than 2 kW. The standards do not have separate requirements based on the battery chemistry, such lithium ion or nickel cadmium.

The CEC report identifies 16 product categories, which are used to estimate the total stock of battery chargers. The report uses 2009 estimates of product category sales and creates forecasts for sales through 2013, and estimates of battery charger stock in 2013. Convergence of products containing battery chargers presents a challenge in estimating the long-term distribution of battery chargers. Some product categories increase functionality, eliminating prior product categories. For example, due to improvements in smart phone technology, the average consumer is more likely to take photographs using a cell phone than a digital camera. The cell phone and digital camera categories have converged.

UECs

UECs are calculated values that depend on assumptions about product usage. Actual usage profiles change as product functionality changes. For simplicity, the CEC study assumes no change in usage of baseline and compliant products. This assumption is reasonable for analyses of battery chargers, though it is likely too simplistic to accurately account for products with increasing functionality without considering the elimination of other product categories.

Another concern with estimating UECs is the products tested to determine the baseline UECs. Neither the CASE report nor the CEC report provides information on how representative the tested technologies are. Testing occurred from 2004 through 2008. Additionally, the resulting power draws are averaged across unknown ranges of power usages; the wider the usage ranges, the less reliable the UEC estimates.

Compliance Rates

Estimating technology adoption rates is challenging; however, neither CASE nor CEC provided any information on how it determined the compliance rates or what period the rates are representative of. D&R believes the compliance rates are most relevant to 2004-2009, when Ecos was testing the power draws of battery chargers. The CASE report states only that the rates are based on lab data and qualitative research trends uncovered through market research.

The Association of Home Appliance Manufacturers (AHAM) questioned the savings analysis and the timeliness of the compliance rates provided in the CASE report. (Clear 2011 and Washington 2011). D&R is unaware of a response from the CEC addressing AHAM's concerns.

Because there are only four compliance rate categories, product category compliance at the extremes of mostly compliant (90%), rarely compliant (10%), and not compliant (0%) is likely over-represented. D&R would require background information on the CASE report to substantiate the compliance rates and determine the potential affect on accuracy, but that level of research and analysis is outside the scope of this report.

Section 3: Oregon Energy Savings

In support of the proposed standard, NEEA provided estimates of 209 GWh of cumulative electricity savings for small battery chargers and 16 GWh of cumulative electricity savings for large battery chargers in 2020.

D&R developed estimates for energy savings resulting from the energy standard for small and large battery chargers, including the following:

- Oregon's full stock turnover annual electricity savings
- Oregon's cumulative electricity savings in 2020

D&R then examined NEEA's energy savings claims, as well as its estimates of when energy savings would occur.

D&R calculated energy savings using product stock data, product lifetimes, UES estimates, and compliance rates. The following equation was used to calculate energy savings for each category:

$$Energy\ Savings_{product\ category} = Stock_{product\ category} \times UES_{product\ category} \times \left(1 - Compliance\ Rate_{product\ category}\right)$$

D&R met with Ecova to discuss the studies for battery chargers and the savings estimate provided by CEC for California.[3] This meeting was extremely important in helping D&R understand the CEC study.

D&R also reviewed the calculations presented in the CEC and CASE reports to provide a sensitivity analysis of the shipments, UECs, and compliance rates used to estimate total energy savings. The sensitivity analysis helped determine the relative importance of shipments and stock, UECs, and compliance rates, in the accuracy of the energy savings.

3.1 Oregon's Full Stock Turnover Annual Electricity Savings

Estimating energy savings in Oregon begins with the CEC analysis on reported savings in California. The energy savings provided by NEEA appear to be scaled savings based on the CEC savings estimates for California.

The CEC report provides savings estimates using the 2009 stock to predict the full stock turnover savings in California. Savings from the standard are the sum of energy savings of battery

[3] Ecova authored a report for California IOUs, *Codes and Standards Enhancement (CASE) Initiative for PY2010: Title 20 Standards Development*, on the impacts of enacting legislation setting efficiency standards for battery chargers. CEC referenced this report in its analysis and determination to pursue energy efficiency standards for battery chargers. Ecos Consulting, which conducted the product testing for the California standard, is now Ecova.

chargers that replace existing units in the stock after 2009. Full stock turnover savings occur once all battery chargers in the stock comply with the energy standard.

To determine total savings, D&R used the stock of battery chargers that CEC estimated for 2009. For the purposes of this analysis, D&R assumed that after 2009 there is no growth in the stock of battery chargers. In this model, the relationship between products shipped and battery chargers is 1:1. The compliance rates are assumed to be current for 2009, when the analysis was completed by Ecova; they represented the rate at which battery chargers complied with the proposed standard.

As discussed above, the CEC estimated savings from the California standard by considering the energy savings when the full stock of battery chargers is replaced at the end of their useful life. NEEA presented the effect of the Oregon standard as annual savings in 2020. In reality, the savings presented by NEEA represent cumulative annual savings from the standard through 2020. Table 3-1 presents calculated energy savings.

Table 3-1. 2009 Total Stock Energy Savings for Battery Chargers in Oregon

Product Category	Unit Energy Saving (UES)	Compliance Rate	Lifetime (years)	Savings of Stock (GWh)
Auto/Marine/RV	316.42	0%	10	68.78
Cell Phones	0.47	90%	2	0.27
Cordless Phones	13.30	0%	5	32.92
Personal Audio Electronics	0.47	90%	3	0.17
Emergency Systems	15.89	10%	7	9.16
Laptops	16.81	10%	4	29.23
Personal Care	1.84	0%	5	1.93
Personal Electric Vehicles	536.84	10%	9.7	5.83
Portable Electronics	1.74	10%	5.2	1.95
Portable Lighting	8.65	0%	10	1.25
Power Tools	14.94	10%	6.5	24.85
Universal Battery Chargers	3.93	50%	8	0.21
Golf Carts	807.74	50%	10	8.54
Emergency Backup Lighting	8.56	50%	10	4.09
Handheld Barcode Scanners	19.68	50%	8	0.31
Two-Way Radios	8.87	50%	8	0.05
Single Phase Lift-Trucks	1032.47	0%	15	3.62
Three Phase Lift-Trucks	4198.48	0%	15	37.52
Total				**230.68**

D&R calculated energy savings of 231 GWh for small and large battery chargers, 6 GWh more than the savings estimated by NEEA.

3.2 Oregon's Annual Electricity Savings in 2020

NEEA also presented the Oregon legislature with estimates of energy savings in 2020. This estimate of energy savings in 2020 allows comparison to estimates of savings from full stock turnover of battery chargers (231 GWh). Determining when the full stock turnover will occur requires estimates of when products are replaced. D&R assumed that the entire 2009 existing stock for a product category would be replaced by the end of that product category's lifetime. D&R assumed an even replacement rate (i.e., products are replaced at a rate equal to the inverse of the product lifetime). Mathematically this is expressed as:

$$Replacement\ Rate_{product\ category} = \frac{1}{Lifetime_{product\ category}}$$

The resulting equation for estimating replaced stock each year is:

$$Replaced\ Stock_{product\ category} = \frac{2009\ Stock_{product\ category}}{Lifetime_{product\ category}}$$

For a product with a lifetime of four years, roughly a quarter of products would be replaced in each year following 2009. Shipments after 2009 were excluded from the likelihood of replacement because it was assumed that those products would remain in circulation until the end of their lifetime. For a product with a lifetime of four years, this would occur in 2013.

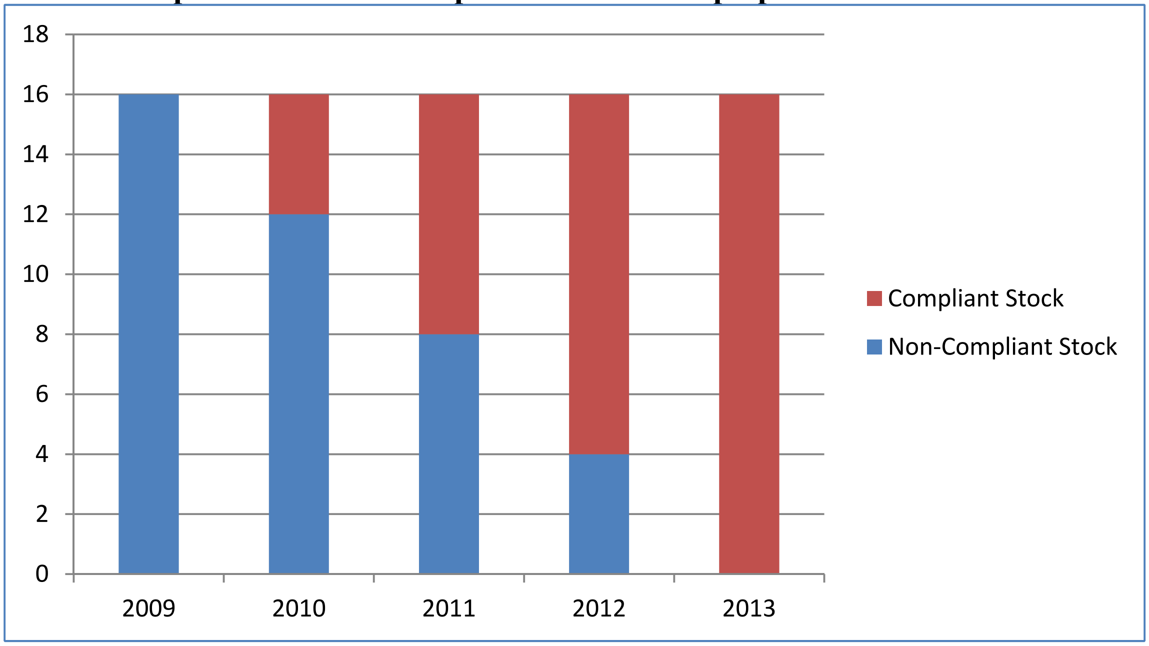
$$Annual\ Stock_{product\ category} = Previous\ Year\ Stock_{product\ category} - Likelihood\ of\ Replacement + Shipments_{product\ category}$$

Overall stock levels remained unchanged from year to year, so D&R assumed that shipments matched replaced stock. The result is an annual increase in the number of compliant products until all stock is compliant. Table 3-2 presents an example of how stock was calculated for laptops, using the CEC's estimated laptop lifetime of four years.

Table 3-2. Stock Example for Laptops (Millions of Units)

Laptops	2009	2010	2011	2012	2013
2009 Products	16.00	12.00	8.00	4.00	0.00
Shipments	0.00	4.00	4.00	4.00	4.00
Compliant Stock	0.00	4.00	8.00	12.00	16.00

Figure 3-1. Compliant and Non-Compliant Stock for Laptops



The 2010 stock for laptops is equal to the 2009 stock of laptops. Of the estimated 16 million laptops in stock in 2009, an estimated 12 million were estimated to be in use in 2010. The 4 million units shipped in 2010 replace the 4 million units taken out of stock. Battery chargers shipped with laptops after 2009 were assumed to comply with the standard.

Full stock turnover for laptops occurs in 2013, which means that battery chargers shipped with all laptops in stock in 2013 comply with the standard. After 2013, replacement and shipments are still estimated at 4 million units per year, but the overall stock volume and compliance rates do not change because full stock turnover has been achieved.

Table 3-3 presents cumulative savings in 2020. These savings are lower than full stock turnover savings because Single Phase Lift-Trucks and Three Phase Lift-Trucks, which have lifetimes of 15 years, still have non-compliant battery chargers in 2020.

Table 3-3. 2020 Annual Energy Savings, by Product Category (GWh)

Product Category	Savings (GWh)
Auto/Marine/RV	68.78
Cell Phones	0.27
Cordless Phones	32.92
Personal Audio Electronics	0.17
Emergency Systems	9.16
Laptops	29.23
Personal Care	1.93
Personal Electric Vehicles	5.83
Portable Electronics	1.95
Portable Lighting	1.25
Power Tools	24.85
Universal Battery Chargers	0.21
Golf Carts	8.54
Emergency Backup Lighting	4.09
Handheld Barcode Scanners	0.31
Two-Way Radios	0.05
Single Phase Lift-Trucks	2.65
Three Phase Lift-Trucks	27.52
Total	**219.71**

3.2.1 Overall Stock Assumptions

D&R then evaluated the impact of shipments on the estimate of cumulative energy savings in 2020 by repeating the cumulative energy savings calculations using product lifetimes that are two years longer, effectively slowing stock replacement. Table 3-4 compares the energy savings achieved in 2020 with standard and lower stock replacement rates.

Table 3-4. Battery Charger Lifetimes and 2020 Annual Energy Savings, by Product Category (GWh)

Product Category	Base Case, 2009 Stock		Reduced Replacement Rate	
	Lifetime (years)	Energy Savings (GWh)	Lifetime (years)	Energy Savings (GWh)
Auto/Marine/RV	10	68.78	12	63.05
Cell Phones	2	0.27	4	0.27
Cordless Phones	5	32.92	7	32.92
Personal Audio Electronics	3	0.17	5	0.17
Emergency Systems	7	9.16	9	9.16
Laptops	4	29.23	6	29.23
Personal Care	5	1.93	7	1.93
Personal Electric Vehicles	9.7	5.83	11.7	5.49
Portable Electronics	5.2	1.95	7.2	1.95
Portable Lighting	10	1.25	12	1.15
Power Tools	6.5	24.85	8.5	24.85
Universal Battery Chargers	8	0.21	10	0.21
Golf Carts	10	8.54	12	7.82
Emergency Backup Lighting	10	4.09	12	3.74
Handheld Barcode Scanners	8	0.31	10	0.31
Two-Way Radios	8	0.05	10	0.05
Single Phase Lift-Trucks	15	2.65	17	2.34
Three Phase Lift-Trucks	15	27.52	17	24.28
Total		**219.71**		**208.92**

Energy savings differ approximately five percent between the base case and the reduced replacement rate case. The difference is small because the savings are estimated for 2020, when almost all product categories are fully replaced, even with a slower replacement rate.

3.2.2 UEC Uncertainty

UECs are calculated based on estimates for battery charger usage profiles and power draws for each mode of operation. Table 2-10 presents baseline and compliant UECs for each product category.

The CEC standard was designed to reduce consumption for each mode of battery charger use. The compliant UECs assume the same usage profiles as the baseline UECs. Savings between the baseline and compliant UECs is therefore the sum of the differences between baseline and compliant power draw in each of the three modes.

The compliant power demand is the maximum allowed power draw in each charging mode. The baseline power demand is derived from tested products that were commercially available at the time of the analysis. The CEC report averages the tested power draw of all products for each mode. A minor concern with testing products' modal power draws is collecting sufficient data on enough products in each product category to assess the power draws; such work is beyond the scope of this report.

UECs do not have a significant impact on estimates for energy savings because both sets of UECs for each product category are calculated using the same usage profile.

3.2.3 Compliance Rate Uncertainty

One significant concern is estimating the efficiency of the stock so that energy savings can be calculated. An assumption of low compliance rates means larger baseline consumption, which indicates a greater likelihood for energy savings. An assumption of high compliance rates means lower baseline consumption and less opportunity for energy savings.

The CEC model characterizes battery chargers shipped with products as compliant or non-compliant. It provides compliance rates as qualitative evidence of the market penetration of the battery chargers. The CEC presents compliance rates as being generated from analysis of lab data and qualitative research, but the CEC has not provided this data to interested parties. D&R does not believe that the CEC responded to AHAM's concerns; during the CEC proceedings, where the 15-day language of the standard was approved, AHAM again noted its questions and lack of response from the CEC.

Another potential issue with the CEC model is the definition of compliance. In the CEC model, products with energy consumption above the standard were classified as non-compliant. For most product categories, the standard was stringent enough that the majority of products did not meet the standard. Because the incremental differences in CEC's four compliance categories are uneven, moving from one compliance category to another has a big impact on savings.

Intermediate battery chargers are labeled as non-compliant, which increases the rate of non-compliant battery chargers. However, the UEC of this intermediate battery charger is not as high as one that is truly not compliant. This methodology can lead to savings potential estimates greater than what is attainable.

Product categories assigned compliance rates of 0% or 10% suggest greater savings potential. Product categories assigned compliance rates of 50% or 90% have small energy savings potential relative to the product category stock; they present less of a concern for estimating total energy savings accurately. Table 3-5 compares 2020 cumulative energy savings under the base case and with compliance rates raised to the next higher compliance category. In the base case, product categories with 0% or 10% compliance rates represent 94% of the total energy savings. D&R advanced the assigned compliance rate one step to mimic the circulation of more efficient technologies in the stock. With the revised compliance rates, energy savings are reduced to 174 GWh in 2020. This demonstrates the effect broad compliance rate categories have on energy savings estimates. While the compliance rates may be correct for some of the battery charger categories, using such broad categories results in unreliable energy savings estimates.

Table 3-5. Compliance Rates and 2020 Annual Energy Savings, by Product Category

Product Category	Base Case		Compliance Rate Increase	
	Compliance Rates	2020 Energy Savings (GWh)	Compliance Rates	2020 Energy Savings (GWh)
Auto/Marine/RV	0%	68.78	10%	61.90
Cell Phones	90%	0.27	100%	0.00
Cordless Phones	0%	32.92	10%	29.63
Personal Audio Equipment	90%	0.17	100%	0.00
Emergency Systems	10%	9.16	50%	5.09
Laptops	10%	29.23	50%	16.24
Personal Care Equipment	0%	1.93	10%	1.74
Personal Electric Vehicles	10%	5.83	50%	3.24
Portable Electronics	10%	1.95	50%	1.08
Portable Lighting	0%	1.25	10%	1.13
Power Tools	10%	24.85	50%	13.80
Universal Battery Chargers	50%	0.21	90%	0.04
Golf Carts	50%	8.54	90%	1.71
Emergency Backup Lighting	50%	4.09	90%	0.82
Handheld Barcode Scanners	50%	0.31	90%	0.06
Two-Way Radios	50%	0.05	90%	0.01
Single Phase Lift-Trucks	0%	2.65	10%	3.25
Three Phase Lift-Trucks	0%	27.52	10%	33.77
Total		**219.71**		**173.52**

3.2.4 Oregon's Annual Electricity Savings in 2020 Uncertainty

D&R assessed the strength of the energy savings estimates by reviewing the assumptions in the three components of the savings analysis: stock of battery chargers, UECs, and compliance rates. Total savings are linear and are tracked for 18 categories of products that utilize battery chargers. Table 3-6 shows the effect on 2020 annual energy savings results of the shipment growth, UEC uncertainty, and compliance rate uncertainty.

Table 3-6. Summary of Uncertainty Assumptions

Scenario	Change	2020 Annual Electricity Savings (GWh)	Energy Savings Change vs. Base Case (GWh)
Base Case	None	219.71	N/A
Stock Assumptions	Increased product lifetime 2 years	208.92	-5%
UEC Uncertainty	No behavior change relative to identical product categories	Small	Negligible
Compliance Rate Uncertainty	Greater preexisting compliance with efficiency standard	173.52	-26%

Assumptions for stock of battery chargers and compliance rates have greater impact on energy savings than UEC uncertainty. The assumptions for stock and compliance rates both result in decreased savings potential. Changes in the UECs used in the savings impact analysis have no effect on savings, as this analysis assumes no change in consumer behavior. Predicting how consumer behavior changes with the introduction of newer products is challenging, and assuming that no behavioral changes occur is a reasonable simplifying assumption.

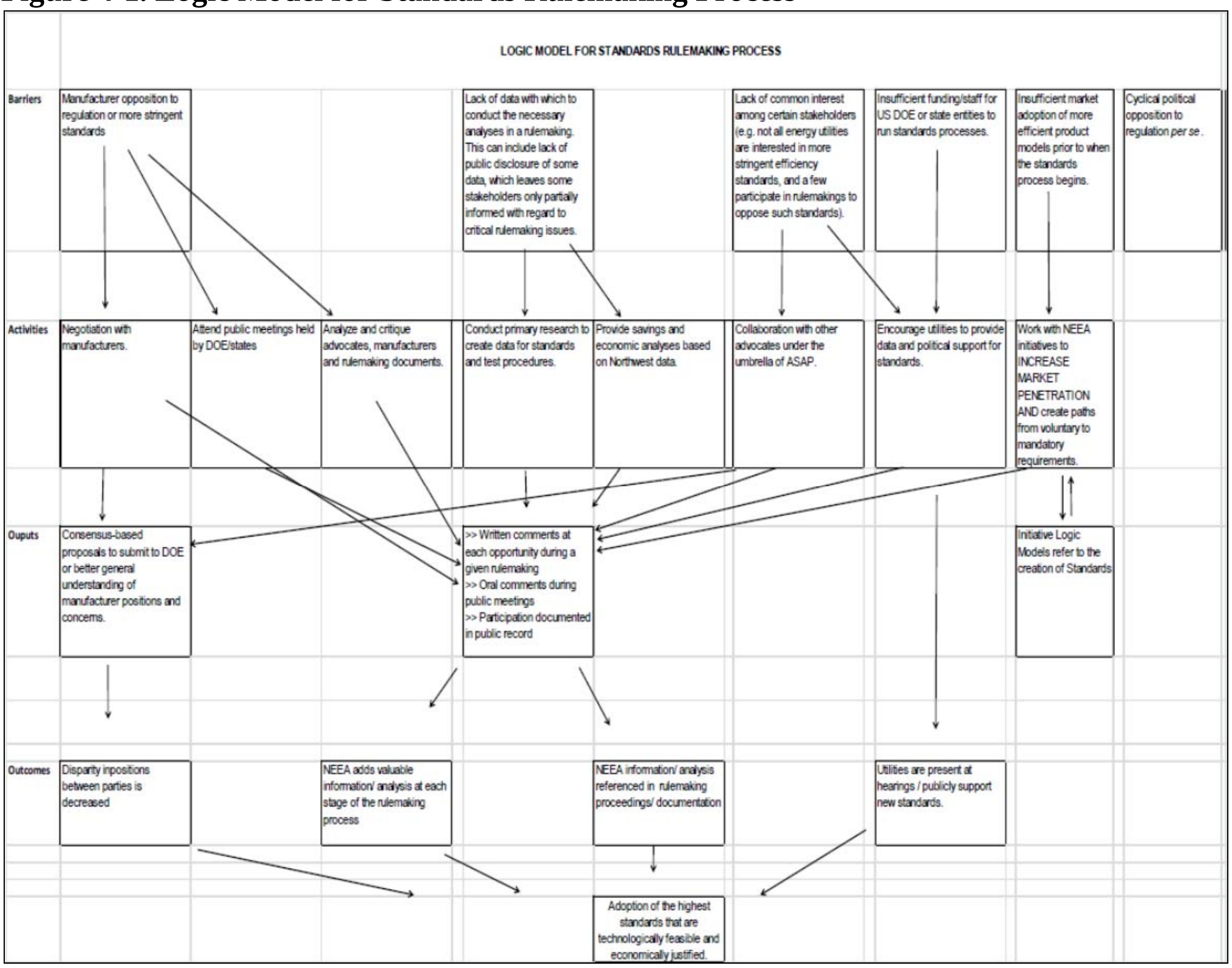
D&R assessed the importance of the compliance rates in CEC's methodology. When D&R repeated the calculations using compliance rates one step above the base case compliance rates, estimated energy savings decreased 26% from the base case.

Though the stock assumptions are important for estimating the impact of the savings analysis, they are less significant than the effects of product lifetimes and estimates of the efficiency of circulating products. Extending battery charger lifetime by two years reduced cumulative energy savings in 2020. The effect on savings would have been even greater if product turnover began after 2010, as fewer non-compliant products would have been replaced by 2020.

Section 4: Logic Model Review

NEEA uses the Standards Logic Model to guide its activities to increase efficiency standards of appliances and building equipment. The Logic Model, shown in Figure 4-1, provides a framework for NEEA to follow in efforts to influence processes establishing standards. The model is similar to a flow chart, where identified barriers require certain activities, resulting in outputs and outcomes. It also provides a framework for evaluators to determine whether NEEA can credibly claim to have influenced any particular energy savings for its work to increase appliance and equipment standards. The Standards Logic Model is designed for NEEA to use during federal rulemaking processes; it is not geared to state legislative proceedings.

Figure 4-1. Logic Model for Standards Rulemaking Process



NEEA asked D&R to review the Logic Model for its effectiveness and completeness and to assess whether NEEA followed it during the legislative process and whether NEEA influenced achieving the highest possible technologically feasible, cost-effective efficiency standard.

To determine the effectiveness of the Logic Model and NEEA's usage of it, D&R reviewed NEEA's activities over the 8-month legislative process related to SB 692 by examining testimony and documentation from the Oregon legislature and interviewing individuals who worked closely with NEEA in the standards process.

4.1 Summary of Legislative Actions for SB 692

SB 692 was drafted and introduced to the Oregon legislature through the Senate Environment and Natural Resources Committee. There were three revisions to SB 692 before it was passed by the House Energy and Environment Committee and then the Senate Committee. SB 692-A also contained efficiency standards for televisions and plumbing products. During the course of the Senate and House committee meetings, SB 692-A was revised to SB 692-B with the removal of plumbing products. SB 692-B was later revised to SB 692-C with the alteration of the efficiency standard for televisions. NEEA had no role in removing the plumbing products from SB 692-B, but was involved in revising the television standard for SB 692-C. The history of the bill as it made its way through the Oregon legislature is presented below.

Figure 4-2. SB 692 Activities

H House S Senate

- S Feb 26, 2013: Introduction and first reading. Referred to President's desk.
- S Feb 28, 2013: Referred to Environment and Natural Resources.
- S Mar 11, 2013: Public Hearing held.
- S Apr 8, 2013: Work Session held.
- S Apr 12, 2013: Recommendation: Do pass with amendments. (Printed A-Eng.)
- S Apr 15, 2013: Second reading.
- S Apr 16, 2013: Third reading. Carried by Dingfelder. Passed.
- H Apr 17, 2013: First reading. Referred to Speaker's desk.
- H Apr 24, 2013: Referred to Energy and Environment.
- H Apr 30, 2013: Public Hearing held.
- H May 7, 2013: Work Session held.
- H May 9, 2013: Recommendation: Do pass with amendments and be printed B-Engrossed.
- H May 13, 2013: Second reading.
- H May 14, 2013: Third Reading. Motion to re-refer to Energy and Environment carried. Re-referred.
- H May 16, 2013: Work Session held.
- H May 17, 2013: Recommendation: Do pass with amendments and be printed C-Engrossed.
- H May 30, 2013: Third reading. Carried by Dembrow. Passed.
- H May 30, 2013: Potential conflict(s) of interest declared by Weidner.
- S Jun 4, 2013: Senate concurred in House amendments and re-passed bill.
- S Jun 6, 2013: President signed.
- H Jun 7, 2013: Speaker signed.
- S Jun 13, 2013: Governor signed.
- S Jun 21, 2013: Chapter 418, 2013 Laws. Effective date, January 1, 2014.

4.2 Implementation of the Logic Model

NEEA's goal in this effort was to help shepherd the passage of SB 692, and NEEA was successful, as SB 692 was passed in June 2013. NEEA's involvement with SB 692 began with a request from the Citizens' Utility Board of Oregon via Senator Dingfelder to provide new energy efficiency legislation following California's establishment of efficiency standards for battery chargers.

4.2.1 Barriers

Because NEEA assisted in drafting legislation identical to California's Title 20 standard for battery chargers passed in 2011, it did not encounter significant barriers from industry stakeholders. NEEA based its analyses on the same information the CEC used for enacting a battery charger standard in California. Advocacy groups were a great resource to the Oregon legislature, as they provided expertise about efficiency standards and familiarity with California's legislation and how it could be enacted in Oregon.

4.2.2 Activities

According to the Logic Model and the legislative process in Oregon, NEEA should have attended public meetings; analyzed and critiqued advocacy group, manufacturer, and rulemaking documents; provided savings and economics analyses based on Northwest data; and collaborated with other advocates under the umbrella of the Appliance Standards Awareness Project. D&R found that NEEA was successful in filling all those roles.

Charlie Stephens, NEEA's Senior Engineer for Codes and Standards, met with Oregon legislators and advocacy groups to discuss the legislation and its effects. NEEA collaborated with the Citizens Utility Board of Oregon (CUB), Northwest Energy Coalition, and Oregon League of Conservation Voters to provide technical expertise for SB 692. The groups worked together to provide any necessary support for enacting the legislation.

NEEA provided initial savings estimates based on the primary data gathered during the California rulemaking process, with adjustments for population differences and other factors to tailor the savings to Oregon. Mr. Stephens represented NEEA in private meetings with legislators throughout the process to discuss the legislation and their concerns. He attended meetings in March, April, and May to assist with drafting legislation, providing technical information on the impacts of the bill, and addressing concerns from opponents who relied on incorrect information. Representative Weidner works for a company that produces products that use battery chargers, and Mr. Stephens provided him with a technical rebuttal to his concern that the efficiency standard would adversely affect the company.

4.2.3 Outputs

The third tier in the logic model is related to NEEA's participation in public meetings during a standard-setting process. This step has three elements: provide written comments at each opportunity during the rulemaking process; provide oral comments during public meetings; and have NEEA's participation documented in the public record.

NEEA provided energy savings estimates to the legislature, and Mr. Stephens provided insightful testimony that aided the legislative process during meetings on March 11 and April 30.

NEEA's participation in the process is well documented in the public record. According to attendance records from the Oregon legislature, NEEA representatives testified at the following hearings:

- On March 11, 2013, during the Oregon Senate Environment and Natural Resources Committee Hearing, Mr. Stephens provided testimony in support of SB 692. He indicated that 60 percent of energy waste occurred when the battery was already charged and that the standard directly targeted that waste. He also explained that the standard was needed because battery chargers are trivial to manufacturers, resulting in little research and development being applied to them. The standard would incentivize manufacturers and would be a very cost-effective way to get energy savings. Mr. Stephens provided the implementation cost of the standard, which was only about $0.50 on average per device and would result in roughly 210 GWh energy savings after seven years.
- On April 30, 2013, during the Oregon House Committee on Energy and Environment Committee Hearing, Mr. Stephens fielded questions from several of the representatives. When the Chairman wanted to know why Oregon needed an efficiency standard, if a federal standard is bound to come out, Mr. Stephens replied that it would push products well past current ENERGY STAR 6.0 plus 15 percent and would mitigate future costs to consumers and producers. Wendy Gerlitz from Northwest Energy Coalition also testified in the same hearing, explaining that Oregon annual bill savings by 2020 would be more than $25 million and that cumulative savings over the lifetime of the products would be in the range of $168 million. She also expressed the fear that without the standard, Oregon would become an outlet for inefficient technologies that could no longer be sold in California.

4.2.4 Outcomes

The next step in the Logic Model has two desired outcomes—that NEEA add valuable information/analysis at each stage of the rulemaking and that NEEA's information/analysis be referenced in rulemaking proceedings/documentation—and NEEA achieved both. Included in the reference documents for SB 692 is a savings chart developed by NEEA, which was used as a reference during public meetings. This satisfies the "information/analysis referenced" step. From interviews of other advocate participants, D&R determined that NEEA was successful in adding valuable information at each stage of the rulemaking. One of the most convincing pieces of evidence came from Marty Stipe of the Oregon Department of Energy, who stated that the passage of the law would not have been possible without NEEA's help and intervention, particularly related to savings estimates.

The final piece of the Logic Model is the "adoption of the highest standards that are technologically feasible and economically justified." NEEA certainly met this objective. The final standard level for SB 692 was set at the highest currently available market technology. While a higher standard would have been technologically possible using products not readily available in the market, it is unlikely that it would have been cost-effective.

4.3 Suggested Improvements

While the Logic Model was successfully implemented during SB 692, NEEA could consider making some adjustments to improve the efficacy of the model for future rulemakings.

- **Clearly state goals and objectives for stakeholders** – Being clear and transparent about its goals and expectations from a rulemaking would help NEEA build awareness and goodwill among its members and the public. NEEA could provide greater clarity regarding its expectations and goals by shifting the Model to work backward from Outcomes to Barriers.
- **Provide and involve a more comprehensive list of stakeholders to improve data capture** – The Logic Model includes manufacturers in the Barriers and Activities tiers, but omits retailers and distributors from the matrix of stakeholders. Retailers and distributors have the best information on current product sales and shipments. Retailers understand how products make it into the marketplace and can provide insight when more efficient products are readily available and consumers don't change their purchase practices. NEEA may want to engage retailers and distributors to determine their costs and collect their input on pricing of new technologies introduced to the marketplace. These stakeholders may also have a role in enforcing efficiency standards. Including them in the rulemaking process helps to build unanimity amongst all stakeholders.
- **Recruit member utilities to work directly in the standards process –** NEEA's member utilities are great assets, and NEEA could use them to leverage its position for increasing efficiency standards. By securing and publicizing member support for efficiency standards initiatives, NEEA could exert great influence.
- **Work in all political climates to increase standards** – The cyclical nature of politics should not prevent any administration from increasing efficiency standards or the legislative branch from proposing new legislation. Appliance and building equipment efficiency standards are generally politically neutral, providing greater benefits than costs and penalties. The analysis for enabling legislation or increasing current standards should be based on credible technical information from trusted industry stakeholders. Members of all political parties will likely support advancing appliance efficiency regulations when analysis indicates that the improved technologies are technologically feasible and economically justified.
- **Expand primary research to include data gaps analysis** – New regulations are almost always based on incomplete data. Including an investigation for data gaps and a sensitivity analysis would help NEEA identify the importance of data, assumptions, and methodology for calculating energy savings, thus ensuring efficiency standards are based on sound analysis.

- **Update market data during rulemaking processes** – Technology availability can change during the often-protracted legislative process, and sometimes more-efficient technologies come on the market, rendering the proposed efficiency standards moot. Factoring the duration of the rulemaking process into the Logic Model and the investigation for data gaps could help alleviate that potential issue.

Section 5: NEEA's Influence on the Oregon Standard

SB 692 was sponsored by Senator Dingfelder, the chairperson of the Senate Environment and Natural Resources Committee. From discussions with Jeff Bissonnette of CUB, D&R learned that Senator Dingfelder sought CUB's assistance in creating new appliance energy efficiency standards for Oregon. Mr. Bissonnette requested input from NEEA, the Oregon League of Conservation Voters, and the NWEC to determine what new appliance energy efficiency standards should be considered by the Oregon legislature.

5.1 CEC Interaction

The energy efficiency standard for battery chargers in SB 692 is virtually identical to the energy efficiency standard enacted by California. NEEA identified California's battery charger efficiency standard as a good option for Oregon and Washington. Mr. Stephens informed the CEC prior to the finalization of the standard in California that he would further the reaches of the battery charger standard by working to enact the same regulations with members of the Pacific Coast Collaborative (Odell 2012). This is significant evidence that NEEA was involved in enacting SB 692 in Oregon.

5.2 Legislative Member Interaction

NEEA worked with Senator Dingfelder, Representative Bailey, Representative Bentz, and Representative Weidner during the legislative process for SB 692. NEEA assisted the Senate Environment and Natural Resources Committee and the House Energy and Environment Committee in drafting the legislation and helped to allay any concerns of committee members.

Mr. Stephens of NEEA met with two opponents of the bill to provide clarity on the impacts of the battery charger standard. In discussions with D&R, Mr. Stephens reported that he met with Representative Weidner to address his concerns about his company's inability to sell products that would not meet the battery charger standard and how his customers would be adversely affected. Mr. Stephens provided evidence that the bill would not affect the company, as the standard applied only to new products and sales of replacement chargers after 2017. He also met with Representative Bentz to discuss DOE's proceedings for battery chargers and the concern that Oregon's standard would usurp national efforts to enact national battery charger standards. Neither Representative voted for SB 692.

5.3 NEEA's Work with Advocacy Groups

D&R interviewed Jeff Bissonnette of CUB, Wendy Gerlitz of the NWEC, and Marty Stipe of the ODOE to learn about their work with NEEA during the six months of legislative hearings. Based on the comments during the interviews, D&R believes that NEEA was influential in the legislative process.

5.3.1 Meetings to Provide Technical Expertise

Members of the legislature, CUB, NWEC, and ODOE relied on NEEA's technical expertise and familiarity with energy efficiency standards for battery chargers. Mr. Stephens' previous employment with ODOE and his relationships with Senate and House legislators and committee staff helped bolster NEEA's credibility and perception as expert in the field. Mr. Stephens attended and testified at committee meetings and met with legislators to provide technical information. He answered general and technical questions from legislators and their staff and provided technical consultation on the merits of SB 692 during the revision process. Mr. Stipe recalled that NEEA attended hearings, testified on the legislation, coached legislative council on drafting and editing the legislation, provided technical advice, and responded to questions. Mr. Stephens also facilitated discussions to encourage decision-making; ODOE appreciates this work and hopes NEEA continues this in the future.

5.3.2 Advocates View Savings Estimates Provided by NEEA as Credible and Essential

Many of the interviewees mentioned that NEEA's technical analysis was essential to the passage of SB 692. Ms. Gerlitz worked with Mr. Stephens on the energy savings estimates provided to the Oregon legislature. NEEA responded to the Oregon legislature's request for a determination of energy savings resulting from passage of SB 692. Mr. Bissonnette stated that the advocacy groups had confidence in NEEA's estimates of energy savings. According to Ms. Gerlitz, the legislators had a few questions on how the calculations were done, but no one challenged the validity or magnitude of the energy savings.

According to Ms. Gerlitz, NEEA did a significant amount of work for the passage of SB 692 and was instrumental in answering questions and reassuring legislators about the effects of the legislation. She also noted Mr. Stephens' detail-oriented approach, ensuring that the energy savings calculations were correct. Ms. Gerlitz recalled that the legislature sought the energy savings of all products covered under SB 692 and NEEA was instrumental in providing a credible and reliable response. Her only concern was how long it took Mr. Stephens to provide detailed savings, as this appeared to show a lack of preparedness on the part of proponents.

Mr. Stipe recalled that the Center for Law and Social Policy, Inc. (CLASP) provided energy savings to the Oregon legislature. CLASP provides technical and policy support to governments working to implement energy efficiency standards and labels for appliances, lighting, and equipment. NEEA and NWEC reviewed and formatted the energy savings. Mr. Stipe said that the energy savings appeared credible, but that there was a concern that the savings did not account for free ridership, specifically those products that already complied with the proposed efficiency standard. He also indicated that many discussions about the energy savings of SB 692 occurred outside of committee and working meetings.

5.4 Advocacy Groups' Perception of NEEA's Work

During interviews with representatives from CUB, NWEC, and ODOE, D&R asked about each group's perception of NEEA, including work completed, NEEA's effectiveness, and any missed opportunities.

Mr. Bissonnette looked to NEEA for its expertise . Mr. Stephens provided expert testimony and analysis that was crucial for securing support to enact SB 692. Ms. Gerlitz noted that NEEA provided expert testimony and was great at communicating the details of SB 692. Ms. Gerlitz believes Mr. Stephens was thorough in doing all the work he could have to ensure the bill's passage.

Mr. Stipe contended that without NEEA's presence and participation in the process, the legislation would not have passed. Mr. Stephens understood the national and regional picture and was very familiar with California's energy efficiency legislation on which SB-692 was modeled. Mr. Stipe mentioned meeting with Mr. Stephens several times during the legislative process and recalled particularly a meeting on February 28, 2013, when he, Mr. Stephens, and other NEEA representatives met with legislators at the Legislative Council's library. During the meeting, Mr. Stephens fielded many technical questions from Representative Weidner. Mr. Stipe noted that Representative Weidner was not receptive to Mr. Stephens's answers.

5.5 Summary

NEEA was significantly involved in drafting and supporting the energy efficiency standard for battery chargers. Mr. Stephens alerted the CEC that NEEA supported the CEC standard and would work to enact a similar efficiency standard for battery chargers in Oregon and Washington.

NEEA worked with the CUB, NWEC, and ODOE in providing technical expertise for passage of SB 692 by the Oregon legislature. Mr. Stephens of NEEA served as the technical liaison for the standard, answering technical questions of individual legislators, which helped guide their understanding of the proposed legislation.

Section 6: Conclusions

6.1 Influence on the Oregon Standard

NEEA provided technical expertise to the Oregon legislation by meeting with legislators and working with advocacy groups to advance the standard. NEEA met with the Senate Environment and Natural Resources Committee and the House Energy and Environment Committee, testifying and consulting on products affected by the standard and how the standard would be enforced. When the legislature requested a determination on the energy savings from enacting a standard, NEEA collaborated with CUB and the NWEC to respond.

The legislature, CUB, NWEC, and ODOE view NEEA as expert in appliance efficiency. D&R's interviews with representatives of the efficiency advocacy groups indicated that the advocates saw NEEA's technical expertise as essential to the legislative process for SB 692.

6.2 Energy Savings

NEEA reported to the Oregon legislature that the energy efficiency standard for battery chargers would save 209 GWh and 16 GWh for small and large battery chargers, respectively, by 2020.

D&R reviewed two studies to assess whether the savings estimates NEEA provided to the Oregon legislature are reliable and credible, and calculated the energy savings for two scenarios, shown in Table 6-1.

Table 6-1. Energy Savings in Oregon from Enacting Battery Charger Energy Efficiency Standard

Scenario	Energy Savings (GWh)
Annual Electricity Savings in 2020	219.71
Annual Electricity Savings of Full Stock Turnover	230.68

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Appendix A

Table A-1. California Standard for Small Battery Chargers

Performance Parameter	Standard
Maximum 24 hour charge and maintenance energy (Wh) (E_b = capacity of all batteries in ports and N = number of charger ports)	For E_b of 2.5 Wh or less: 16 × N
	For E_b greater than 2.5 Wh and less than or equal to 100 Wh: 12 x N +1.6 E_b
	For E_b greater than 100 Wh and less than or equal to 1000 Wh: 22 x N+1.5 E_b
	For E_b greater than 1000 Wh: 36.4 x N +1.486 E_b
Maintenance Mode Power and No Battery Mode Power (W) (E_b = capacity of all batteries in ports and N = number of charger ports)	The sum of maintenance mode power and no battery mode power must be less than or equal to: 1x N+0.0021xE_b Watts

Table A-2. California Standard for Large Battery Chargers

Performance Parameter		Standard
Charge Return Factor (CRF)	100 percent, 80 percent Depth of discharge	CRF≤ 1.10
	40 percent Depth of discharge	CRF ≤ 1.15
Power Conversion Efficiency		Greater than or equal to: 89 percent
Power Factor		Greater than or equal to: 0.90
Maintenance Mode Power (E_b = battery capacity of tested battery)		Less than or equal to: 10 + 0.0012E_b W
No Battery Mode Power		Less than or equal to: 10 W

Figure A-1. Oregon Large Battery Chargers Performance Standard

(19)(a) Large battery charger systems must meet the minimum efficiencies in the following table:

Standards for Large Battery Charger Systems

Performance Parameter		Standard
Charge Return Factor	100 percent Depth of Discharge	Crf ≤ 1.10
	80 percent Depth of Discharge	Crf ≤ 1.10
	40 percent Depth of Discharge	Crf ≤ 1.15
Power Conversion Efficiency		≥ 89 percent
Power Factor		≥ 0.90
Battery Maintenance Mode Power (E_b = battery capacity of tested battery)		≤ 10 +0.0012E_b W
No Battery Mode Power		≤ 10 W

Figure A-2. Oregon Small and Inductive Battery Chargers Performance Standard

(b)(A) As described in subparagraph (B) of this paragraph, inductive charger systems and small battery charger systems must meet the minimum energy efficiency standards in the following table:

Standards for Inductive and Small Battery Charger Systems

Performance Parameter	Standard
Maximum 24-hour charge and maintenance energy (Wh) (E_b = capacity of all batteries in ports and N = number of charger ports)	For E_b of 2.5 Wh or less: 16 x N For E_b >2.5 Wh and ≤ 100 Wh: 12 x N+1.6E_b For E_b >100 Wh and ≤ 1000 Wh: 22 x N+1.5E_b For E_b > 1000 Wh: 36.4 x N + 1.486E_b
Battery Maintenance Mode Power and No Battery Mode Power (W) Power Factor (E_b = capacity of all batteries in ports and N = number of charger ports)	The sum of battery maintenance mode power and no battery mode power must be less than or equal to: 1 x N+0.0021xE_b

Appendix B

Unit energy consumption (UEC) is calculated based on energy consumption in the four operational modes of a battery charger: Active, Maintenance, No Battery (Standby), and Off. Calculating energy consumption requires assumptions about the time spent in each operational mode of the battery charger. The assumptions used in the CEC models are shown in Tables B-1 and B-2.

Table B-1. CEC Operational Mode Assumptions

Product Categories	Active (% of time)	Maintenance (% of time)	No Battery (% of time)	Off (% of time)
Auto/Marine/RV	1%	42%	46%	10%
Cell Phones	3%	30%	19%	48%
Cordless Phones	35%	56%	9%	0%
Personal Audio Electronics	2%	25%	35%	38%
Emergency Systems	0%	100%	0%	0%
Laptops	4%	56%	30%	10%
Personal Care	3%	86%	3%	9%
Personal Electric Vehicles	36%	28%	35%	1%
Portable Electronics	1%	11%	1%	87%
Power Tools	2%	48%	13%	37%
Universal Battery Chargers	0%	66%	17%	17%
Golf Carts	20%	47%	13%	19%
Handheld Barcode Scanners	13%	52%	35%	0%
Two-Way Radios	19%	31%	50%	0%

The assumptions about time spent in each operational mode were then used to calculate UEC, by applying the following formula[4]:

$$UEC = 365*(E_{Active} + E_{Maint} + E_{NoBatt} + E_{Off})$$

Active mode energy (E_{Active}) is the energy consumed while the battery charger is in active mode. Another way to express this is through the equation:

$$E_{Active} = n(E_{24} - P_m(24 - t_c) - E_{batt})$$

Where:
n is the number of charges per day
E_{24} is the 24-hour energy of the battery or the amount of energy required to charge a fully depleted battery and maintain the full charge over a 24-hour period

[4] DOE and CEC determined the inputs to this equation and the following equations by testing products. DOE and CEC tested similar products, so any variations in the data were the result of different technology available on the market at the time that testing was conducted. Because DOE conducted its testing after the CEC report was completed and technological advancements occur rapidly, it is possible that variations were the result of different requirements of emerging or evolving technology.

$\mathbf{P_m}$ is the energy consumption of the battery in maintenance mode
$\mathbf{t_c}$ is the time it takes to fully charge the depleted battery
$\mathbf{E_{batt}}$ is the measured battery energy, or battery capacity in Wh

Subtracting the time it takes to fully charge a battery from 24 hours returns the time spent in maintenance mode. Multiplying that time by maintenance mode power gives the energy consumed while in maintenance mode. Subtracting maintenance mode consumption and battery capacity from the battery's 24-hour energy yields the energy consumed while in active mode. The product of the number of charges per day and energy consumed in active mode is the amount of energy per day consumed in active mode.

Maintenance mode energy (E_{Maint}) is the energy consumed while the battery charger is in maintenance mode, defined by the equation:

$$E_{Maint} = P_m(t_{a\&m} - (t_c\ n))$$

Where:
$\mathbf{P_m}$ is the energy consumption of the battery in maintenance mode
$\mathbf{t_{a\&m}}$ is the time per day spent in active and maintenance mode
$\mathbf{t_c}$ is the time it takes to fully charge the depleted battery
n is the number of charges/day

The product of time to completely charge the battery and the number of charges per day is the time spent in active mode. By subtracting time in active mode from time in both active and maintenance modes returns the time spent in maintenance mode. Multiplying the time in maintenance mode by the energy consumed in maintenance mode in watt hours results in the energy consumed in maintenance mode per day.

Standby (no-load) mode energy is the energy consumed while in standby mode, represented by the equation:

$$E_{NoBatt} = (P_{sb}\ t_{sb})$$

Where:
$\mathbf{P_{sb}}$ is the energy in watts per hour consumed while in standby mode
$\mathbf{t_{sb}}$ is the time per day in hours, spent in standby mode

The product of standby mode energy and time spent in standby mode is the energy consumption while in standby mode.

Off mode energy is the energy consumed while the battery charger is unplugged or is not providing power to the battery. Off mode or unplugged mode energy consumption is always zero.

$$E_{Off} = P_{Off}\ t_{Off}$$

Where:
$\mathbf{P_{Off}}$ is energy consumed in watts per hour while in off mode
$\mathbf{T_{Off}}$ is time per day spent in off mode

Memorandum

March 26, 2015

TO: D+R International

FROM: Steve Phoutrides, Project Manager, NEEA Market Research & Evaluation

SUBJECT: Comment on the D&R Battery Charger Standards Report

NEEA accepts the assessment of D&R International which states that based on the data provided by the CEC, the full stock turnover savings resulting from passage of the Battery Charger legislation are 230.68 GWh and 2020 annual energy savings are 219.71 GWh.

However, for its Funder Savings Report, NEEA will not use the above estimates. Instead NEEA will report estimates which were developed as part of a comprehensive project sponsored by Bonneville Power Administration (BPA) – BPA Standards Impact Analysis. With this project, BPA has standardized the approach to estimating savings from standards, making the region more efficient in terms of time and resources both in developing and in communicating the most accurate estimates.

NEEA believes it is important to support BPA's approach as it creates a standardized approach to estimate energy savings from any enacted standards.

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