Momentum Savings from Appliance Standards

Bonneville
POWER ADMINISTRATION

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Executive Summary

Every day, codes and standards have a dramatic impact on energy demand in the Pacific Northwest. Over a twenty-five year analysis period, the appliance standards analyzed in this project alone represent a resource on par with an entire dam – 1500 aMW. This is enough to power over one million homes and illustrates the sheer magnitude of savings that standards deliver. In addition to creating a large and lasting impact on demand, standards are ever evolving – increasing in stringency for existing regulations and expanding scope to cover previously unregulated products. Since their inception, federal and state efficiency standards have all but eliminated the most inefficient products from the market. Together, the magnitude and ubiquity of standards impacts is changing the way resource planners view efficiency acquisition, and altering the arena of demand-side management policy and strategy.

In 2013, The Bonneville Power Administration (BPA) contracted Navigant ("the research team") to conduct standards impact analysis specific to the Northwest for 30 federal appliance standards. Since then, more standards have been announced and the research team conducted a second round of analysis to estimate the total energy resources for 15 additional appliance standards. This report builds upon the first round of this project and details the collective savings of 45 standards while examining the findings of the second round in greater detail. This report also aims to document many of the improvements to the tools and processes made in the second round of the project.

The second round of this project had three main goals:

1. Estimate the total energy resource from 2010 to 2034 provided by 15 appliance standards including 14 federal standards plus the state of Oregon energy efficiency standard for battery chargers
2. Track the Momentum Savings from these standards toward the Bonneville Power Administration's (BPA's) energy efficiency Sixth Power Plan achievements[1]
3. Increase stakeholder review and data quality through initiatives which promote model transparency, ease of use, and a streamlined collaborative review process

Prior to collecting the requisite data needed to build each appliance standards model, the team revamped the model template used in the first iteration and developed common user guides to assist stakeholders in their review. Upgrades to the models included introducing a common structure, using standard naming conventions, and color coding inputs and calculations. The research team also added a navigation tab, which provides an overview of how data flows throughout the model, and hyperlinks to navigate between tabs. Finally, the team developed a central repository to track and respond to reviewer comments on draft models.

With the new tools in place, the project team conducted extensive secondary data collection to revise the central stock-turnover models for the residential and commercial sectors, as well as develop individual

[1] Momentum Savings from federal codes and standards count towards the Bonneville Power Administration's conservation commitment, as long as the given code or standard was not accounted for by the Council in the Sixth Plan baseline.

appliance standards models for each product considered in this round of analysis.[2] This effort included gathering the most up to date market and usage data, much of which was unavailable at the time of the Sixth Plan's publication. In addition to internal reviews by BPA engineers, numerous stakeholders reviewed the models, including those from the Northwest Power and Conservation Council (NWPCC or the "Council"), and the Northwest Energy Efficiency Alliance (NEEA), among others. These reviews helped ensure the use of the best available data and align models with the region's Fifth and Sixth Power Plan assumptions. With this collaboration, the project team built 15 new appliance standards models. Each is capable of comparing scenarios with and without the new standards in order to estimate the standards' impact on energy savings relative to the Plans' assumptions from 2010 to 2034.

[2] A stock-turnover model tracks the year-by-year shipments (flow) and installed base (stock) of appliances in a given area by modeling each products annual retirements, replacements, and new installations. The stock-turnover models are separate from the individual appliance standards models.

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First… A Treatise on Savings Terminology

The list of culprits is long and mercurial: *annual, claimable, incremental, first-year, one-time, cumulative, non-programmatic, programmatic, standards-induced, naturally occurring, in-the-baseline, baseline-adjusted*, etc. The first 20 pages of this report would prove an inadequate space for the definitions of all the different types and categories of "energy savings" used in the Northwest and in the industry at large. The jargon is often necessary for making distinctions among how savings are calculated, or how they are aggregated over time, or how they are adjusted for attribution and baseline issues. However, the nomenclature can render the uninitiated reader utterly nonplussed, downright angry (*why don't the values in second row sum to that column in the bar chart?!?!*), or worse – skeptical. Meanwhile, the initiated may apply their own understanding to the same terms and embark unawares of what we really mean to say.

To avoid a confused and potentially hostile readership, we define and discuss a few key terms. We use these terms—and only these—to define the savings we report herein.

Energy savings. All savings in this report reflect the energy savings achieved by an above-baseline measure *in the first year following its installation*. This concept is often referred to as "incremental" savings. Even though the measure continues to save energy throughout its life relative to the baseline, only the kilowatt-hour savings that accrue in the first year are reported as "incremental" savings for that measure. Those savings are assumed to occur in perpetuity. Furthermore, when reporting savings for more than one year, those savings reflect the simple addition of year-by-year first-year savings. The term "cumulative savings" describes savings that accrue in this manner.

This meaning is consistent with how the Bonneville Power Administration, the Northwest Power and Conservation Council (NWPCC or the "Council"), and the Northwest region calculate and report savings toward the Sixth Power Plan's (Sixth Plan) target. However, it is *not* consistent with how the U.S. Department of Energy (DOE) estimates and reports savings from its standards rulemakings, which are central to this project. DOE's reported savings include all savings from an above-baseline unit throughout the life of that unit. The savings are in addition to the unit's replacement, and its replacement's replacement, and so on, over some finite analysis period (typically 30 years). This accounting method is appropriate when viewed from the standpoint of assessing a standard's cost effectiveness to the consumer or in accounting for carbon abatement. It is unnecessary for analyses aimed at quantifying the resource provided by energy efficiency.

Momentum Savings. Momentum Savings is an umbrella term meant to capture all savings that accrue in the market over and above an NWPCC plan baseline, but which are not incented by utility programs. Core characteristics of Momentum Savings include the following:

1. Momentum Savings excludes savings incented by programs.
2. Momentum Savings must be above an NWPCC plan baseline.
3. Momentum Savings are real savings. Consider the fact that at least some above-baseline widgets or measures occur outside of programs. In fact, significant shares of above-baseline sales are not run through programs in some markets. Yet those non-rebated widgets achieve savings just the

same—same unit, same baseline, and, ultimately, the same resource. That is why the Council is indifferent to how the target is achieved (and why Momentum Savings count toward the target).

4. Momentum Savings estimation has the following two key challenges:

    a. Data availability. While programs typically have data on the number of units sold or jobs performed, quantification of Momentum Savings often requires a broader set of market-level data (in order to assess what occurred outside of programs). Market research is paramount.

    b. Risk of double-counting or undercounting. One cannot simply estimate total market savings—again, relative to an NWPCC plan baseline—and then subtract out programmatic savings. First, program baselines do not always align with NWPCC plans. Second, Northwest Energy Efficiency Alliance (NEEA) initiatives drive savings that must be reconciled with Momentum Savings estimates.

Standards-driven savings. These are energy savings that accrue in the region because of national minimum efficiency standards, as modeled in this analysis.

The relationship between Momentum Savings and standards-driven savings. Given the above definition of standards-driven savings, it is tempting to think that because these savings are not achieved through programs, they must be Momentum Savings. In reality, however, some savings are and some are not. This is because the standard may have been assumed in an NWPCC plan baseline (recall that to count as Momentum Savings, the savings must be above an NWPCC plan baseline). If, for example, the Council knows a DOE standard will take effect in the first year of an NWPCC plan period, then it would likely make the new standard the baseline for that plan. Therefore, in this instance, the new standard cannot drive any Momentum Savings: the standard is not above the plan baseline.

Thus, the savings associated with a hypothetical DOE standard would affect *neither* the claimable programmatic savings nor the claimable Momentum Savings. Does that mean the DOE standard caused no savings, and provided no resource for the region? No. The savings from the standards are simply already "in the baseline" of the new plan. The standards-driven savings are quite real (and, as you see in this report, quite substantial); they simply cannot count toward the target in this case. Conversely, if a standard takes effect that the Council did *not* assume in a plan, then the savings from the standard would count as Momentum Savings; the standard generates savings above the plan baseline. The planners' choice of where to draw a plan baseline has no bearing on the actual impact of the resource provided by the standard to the region.

Sixth Plan Baseline Adjustments. The team calculated baseline adjustments to reconcile the difference between the market efficiency assumed in the Sixth Plan and the market efficiency as modeled with the benefit of hindsight. To use the best available and most current information, the project team diligently collected data that were unavailable to the NWPCC at the time it developed the Sixth Plan. New data from NEEA's Residential Building Stock Assessment, for example, provided updated operating hour and duty cycle information for a number of appliances. Similarly, new shipment data provided a different picture of the market size and efficiency mix for some products. The new data led to different baseline energy consumption in the models as compared to the Sixth Plan. Does this mean that the Sixth Plan was wrong? Not exactly. It was written with the best available data at the time. However, where program efficacy is measured against the Sixth Plan baseline, it is important to get the assumed starting market efficiency correct. Where new data revealed a different market efficiency mix from the Sixth Plan, the baseline must be adjusted.

Where possible, the team isolated the assumed efficiency mix in the Sixth Plan, and then substituted it in the updated models to create an apples-to-apples comparison of assumed market efficiency. The difference in energy consumption with each of these assumptions yielded the baseline adjustments. This calculation was carried out for each year of the Sixth Plan (2010 – 2015) to capture any effect of assumed stringency or timing of standards as well as other changes of market efficiency over time. The adjustment values are given in average megawatts and can be either positive or negative, depending on whether the Sixth Plan assumed a market that was more or less efficient than it was in actuality.

Abbreviations and Acronyms

aMW – Average megawatts

AHAM – Association of Home Appliance Manufacturers

ASAP – Appliance Standards Awareness Project

BPA – Bonneville Power Administration

CAC – Central air-conditioning

CBSA – Commercial Building Stock Assessment

CFL – Compact fluorescent lamp

CFLK – Ceiling fan lighting kit

CFR – Code of Federal Regulations

CSIQ – Codes and Standards Impact Quantification

DHW – Domestic hot water

DOE – U.S. Department of Energy

EF – Energy Factor

EIA – U.S. Energy Information Administration

EISA – Energy Independence and Security Act

EPACT – Energy Policy Act

EPS – External power supply

EUI – Energy use intensity

EUL – Effective Useful Life

HID – High-intensity discharge

HVAC – Heating, ventilation, and air-conditioning

LED – Light-emitting diode

LFL – Linear fluorescent lighting

NAECA – National Appliance Energy Conservation Act

NEEA – Northwest Energy Efficiency Alliance

NIA – National impact analysis

NPS – Non-programmatic savings

NWPCC – Northwest Power and Conservation Council

PNWRES - 1992 Pacific Northwest Residential Energy Survey

PNWNonRES - 1992 Pacific Northwest Non-Residential Energy Survey

PTAC/HP – Packaged terminal air-conditioning/heat pump

RBSA – Residential Building Stock Assessment

RTF – Regional Technical Forum

TSD – Technical support document

UEC – Unit Energy Consumption

UES – Unit Energy Savings

WICF – Walk-in coolers and freezers

Key Insights

Both the modeling and the data collection activity yielded several key insights:

The efficiency resource from standards is extremely large. This iteration of standards analysis identified another 586.1 average megawatts (aMW) of resource from energy efficiency standards. This is in addition to the 960.2 aMW identified in the first round of analysis. Together, these standards represent a resource comparable to that provided by an entire dam. While this analysis reflects the combined savings from 45 standards, the savings are highly concentrated with the bulk of savings coming from just a few high-impact products. From this iteration of the analysis, an estimated 328.4 aMW of savings will accrue just from battery chargers, electric motors, and furnace fans. The Seventh Power Plan baseline will likely include these standards, but nevertheless, the resource achieved by these standards is real, large, and significantly alters the planning horizon.

Oregon standards for battery chargers are among the biggest contributors to Momentum Savings. Efficiency standards for 18 classes of battery chargers ranging in size from personal audio devices to three-phase lift-trucks, took effect in 2014. These standards are modeled after the California standards which took effect in 2013 for consumer products (e.g. personal audio devices), in 2014 for industrial products (e.g. lift-trucks), and will take effect in 2017 for small commercial products (e.g. handheld barcode scanners). Analysis indicates that these standards will contribute 65 aMW in savings in the five years following their adoption (2014-2018) – on par with those realized through the standards for residential water heaters (64 aMW). Further, these standards dominate all others analyzed in the second round of analysis. This is in part due to the fact that the research team expects these standards to become de facto for the region (reflected in the preceding figures) as manufacturers, distributors, and retailers have a substantial disincentive to maintain parallel inventories and supply chains between states. However, interviews with manufacturers, distributors, and retailers would inform these assumptions.

Stakeholder participation yields more accurate estimates of savings from appliance standards. Numerous data points factor into estimating Momentum Savings from standards. These include market saturations, product lifetimes, prevailing efficiency mixes, and more product specific usage metrics than there are products themselves. Each one of these inputs can have a substantial impact on the estimated market size or unit annual energy consumption of a given appliance. For example, do households in the Pacific Northwest run their clothes dryers 224 cycles per year or 311 cycles per year (almost 50% more)?[3] Stakeholder review helps ensure the best possible data finds its way into the analysis and that the modeling teams interpret it correctly. This round of modeling focused on improving the models and review process to encourage this type of participation. However, there is certainly further room for improvement.

[3] 224 cycles per year represents the market weighted average as calculated using 2012 RBSA data and Sixth Power Plan housing estimates. In contrast, 311 cycles per year represents the mean number as taken from NEEA's 2014 Dryer field study.

Results

The definition of "savings" that applies for this analysis is consistent with how the Council, BPA, and other regional stakeholders discuss savings. Unless otherwise stated, the savings expressed herein refer to incremental savings in each year, sometimes referred to as "first-year savings."[4]

For this round of analysis, BPA's standards-driven claimable Momentum Savings from 2010 to 2015 is 0.5 aMW in the residential sector, 2.8 aMW in the commercial sector, and 11.1 aMW for battery chargers and external power supplies (both of which represent a mix of residential and commercial products). This additional 14.5 aMW of savings is on top of the 68.4 aMW identified in the previous round of analysis.

The magnitude of the savings highlights the power of regional standards which comprise the vast majority (over 70%) of savings identified in this round from 2010-2015. Table ES-1 illustrates the breakdown of the 2014 analysis results comparing Federal and State energy efficiency standards.

Table ES-1. Summary of BPA Savings from Round 2 Federal and State Standards, adjusted for Busbar

	2010	2011	2012	2013	2014	2015	Total
Federal Standards	0.0	0.0	0.0	0.0	0.1	3.3	3.4
State Standards	0.0	0.0	0.0	0.0	5.8	5.4	11.1
Total	0.0	0.0	0.0	0.0	5.9	8.7	14.5

Source: Navigant Analysis, 2015

Table ES-2 summarizes the BPA results from 2013 analysis and 2014 analysis. A total of 82.9aMW is available through all analyzed products from 2010-2015.

Table ES-2. Summary of BPA Savings from Analyzed Federal and State Standards, adjusted for Busbar

	2010	2011	2012	2013	2014	2015	Total
Total – Round 1, Non-Lighting Products	3.9	4.0	3.9	4.3	4.1	14.4	34.5
Total – Round 2, Non-Lighting Products	0.0	0.0	0.0	0.0	5.9	8.7	14.5
Total – Lighting Products	0.0	1.4	6.9	9.6	9.2	6.9	33.9
Total	3.9	5.3	10.8	13.9	19.1	30.0	82.9

Source: Navigant Analysis, 2015

[4] Only the first year savings count toward the target, despite the fact that savings from above-baseline measures occur in perpetuity. This is different from how DOE reports savings from its rulemakings.

NEEA reports savings for battery chargers, residential clothes dryers, dishwashers, and clothes washers. The research team subtracted the incremental savings from these products from BPA's Momentum Savings. In addition, BPA's non-residential lighting momentum savings model captures the momentum savings from lighting standards also analyzed in this project. The research team removed the momentum savings yield from lighting standards from this analysis to avoid double counting between this and the non-residential lighting momentum savings analysis. Table ES-3 details the remaining BPA momentum after correcting for NEEA claimed savings, overlap between lighting standards momentum savings and non-residential lighting momentum savings, and a baseline adjustment. The deduction amounts to 46.4 aMW from 2010-2015.

Table ES-3. BPA Momentum Savings before and after Adjustments for 2010-2015

Category	Savings (aMW)
Momentum Savings from Standards	82.9
Less Savings from Lighting Products	-33.9
Less Savings Reported by NEEA	-12.0
Less Baseline Adjustment	-0.5
Remaining Momentum Savings	36.5

Source: Navigant Analysis, 2015

Introduction and Purpose

The Northwest Power and Conservation Council (NWPCC or the "Council") establishes regional energy conservation targets every five years. In 2009, when the Council established a target of 1,200 average megawatts (aMW) for the 2010-2015 "Sixth Plan" timeframe, Bonneville Power Administration (BPA) committed to achieving the public power portion of that resource target—approximately 504 aMW. The Council is indifferent to how BPA achieves those savings, whether through utility programs and incentives, codes and standards, or other means of market transformation. BPA's chosen strategy for achieving its substantial share of the target includes the acquisition of two types of savings: programmatic (those savings BPA directly incentivizes) and momentum (all non-incentivized savings). This report discusses the Momentum Savings side of this strategy, and more specifically, the contribution of standards to Momentum Savings.

Codes and standards are a significant source of Momentum Savings in the Northwest, and since 1980, account for an estimated 40% of conservation energy savings in the region.[5] In the years preceding the submittal of the Sixth Plan (the Plan), the U.S. Department of Energy (DOE) and Congress were particularly active in establishing new or higher efficiency standards. This created the possibility of substantial standards-driven Momentum Savings in the region. To estimate the regional impact, BPA contracted Navigant Consulting, Inc. (Navigant) to conduct an analysis of many DOE standards on important residential appliances and commercial equipment.

The Navigant research team developed the overarching standards impact analysis methodology—coined the Codes and Standards Impact Quantification (CSIQ) Process—in 2011, modeling it on DOE's National Impact Analyses (NIAs).[6] The methodology envisioned the construction of product-specific models that make use of the best available energy and market data in the nation. The research team used these models to:

- Retrospectively estimate Momentum Savings due to standards
- Serve as a transparent tool for multiple parties to use when informing future regional efficiency efforts
- Provide custom standards impact assessments integrating current regional efforts and existing data sources

This report builds on the CSIQ efforts from 2011 and provides the results of a second iteration of codes and standards analysis. In the first round of the standards project, the research team analyzed 30 appliance standards in accordance with the CSIQ methodology. The second round added another 15 standards comprised of 14 federal standards and one Oregon state standard. The following sections detail improvements made to the analysis methodology since the first round, the results of the analysis, and a discussion of improvements to consider implementing in future iterations of this project.

Methodology

The objective of this project was to analyze the impact of standards that took effect during the Sixth Plan timeframe (2010-2015) over a 25-year analysis period. This section describes the analyses' methodology.

The research team executed the analysis in three phases:

1. Screening standards for the analysis
2. Data collection and analysis
3. Stock modeling and savings estimation

In each phase of the project, the team created numerous workbooks including prioritization tools, proposed data forms, stock turnover models, and appliance standards Momentum Savings models. Each

[5] See the report, "Methodology for Quantifying the Savings from Codes and Standards," available here: http://www.bpa.gov/energy/n/reports/evaluation/multi_sector/pdf/BPA_Codes_Standards_Approach_Final.pdf
[6] Ibid

workbook builds upon those in earlier phases with the process culminating in the Momentum Savings models. These models aim to estimate the energy savings impact of appliance standards and to serve as a resource for future regional analyses in the Northwest. With this in mind, extensive stakeholder input, data sharing, and review guided the team's analytical judgments and methodological decisions during each phase of the analysis.

Screening Process

In the first iteration of this project, the research team identified all federal, Oregon, and Washington appliance and equipment standards that went into effect between 2005 and 2015. In all, the team identified 47 standards on consumer products and commercial equipment that would affect energy consumption in the residential and commercial sectors.[7] With guidance from BPA, the Council, and the Northwest Energy Efficiency Alliance (NEEA), the research team prioritized 30 appliance standards for analysis. The team selected these 30 standards based on the magnitude of potential savings, value of data and analysis to the region, and the interaction amongst products.[8]

The research team repeated the screening process for the second iteration of analysis, and reviewed DOE rulemaking status for all products and equipment that have already or are expected to take effect in the foreseeable future. The team identified 14 additional standards, including the Oregon battery chargers standard which meet this criteria. While DOE groups residential cooktops and ovens into a single standard rulemaking, this analysis considers these products separately, resulting in 15 distinct analyses.

Table 1 displays the final products the research team selected for analysis in the current iteration of the project. Refer to Appendix B: Product Standards That Took Effect from 2005 to 2020 for the full list of standards that went into effect (or will go into effect) between 2005 and 2020.

[7] The terms "consumer product" and "commercial equipment" have specific regulatory meaning in the context of DOE's Appliance Standards Program. For simplicity, in this report, we will use the term "product" to mean the regulated device, regardless of the sector in which it is used predominantly.

[8] For more in-depth discussion of selection criteria for the 2013 project cycle, refer to 2013 final report on standards impact project. "Momentum Savings from Appliance Standards

Table 1. Products Selected for Analysis

Sector	Products
Residential	• Central Air-Conditioning • Clothes Dryers • Cooktops • Ovens • Furnace Fans • Microwave Ovens • Room Air-Conditioning
Commercial/Industrial	• Walk-In Coolers and Freezers • Commercial Refrigeration Equipment • Automatic Commercial Icemakers • Beverage Vending Machine • Electric Motors • Small Electric Motors
All Sectors	• External Power Supplies • Battery Chargers

Source: Navigant Analysis, 2015

Data Collection and Sources

Models are only as good as the inputs that drive them. With the appliances standards selected, the team dedicated a substantial portion of the project to secondary data collection to fully understand the inputs required for the appliance standards models. These data inputs fall into four groups:

1. **Standards data:** These data include the applicability, timing, and stringency of standards, which are often surprisingly complex. A single "DOE standard" can affect many different types of regulated products differently and at different times. For example, the standard for "walk-in coolers and freezers" is actually a set of standards on three separate products: the door, the panels, and the refrigeration system. The standard further differentiates each component into a number of product classes, and each class has its own standard level. Collection efforts covered the following three types of standards data:

    a. *The product types or "classes" that standards affect.* Numerous factors may delineate product classes. Examples include capacity bins (e.g., >=1,000 lb. ice/ 24 hrs. harvest rate or <1,000 lb. ice/ 24 hrs. harvest rate for remote condensing automatic commercial ice makers), fuel used (e.g., gas vs. electric clothes dryers), or some feature that provides utility to the consumer and affects energy consumption (e.g., self-cleaning vs. non-self-cleaning ovens.) Note that for the purposes of this analysis, the research team only considered electrically powered products.

b. *The timing of standards*. DOE typically announces new federal appliance standards three years in advance of their required compliance date. After the standard takes effect, manufacturers may no longer produce and sell non-compliant appliances and equipment. Occasionally, different product classes will have different compliance dates.

c. *The stringency of standards*. DOE is required by law to set standards at a level which achieves the greatest national energy savings and is both technologically feasible and economically justified. These criteria result in different standard levels for different appliances and equipment. The stringency of these standards is a critical input to the appliance standards models as it dictates just how far the baseline moves.

2. **Market data**: These data describe the count, type, and efficiency of the products comprising the sales of a given product and include:

    a. *The distribution of product classes analyzed.* As described earlier in this section, DOE standards cover multiple product classes. However, it is rare that product classes are equally represented in the market. Fuels, features, and price points (among other attributes) may cause the market to favor one product class over another. Understanding the relative proportion of each product class in the market is critical to understanding the magnitude of the impact as each product class has its own standard level.

    b. *The distribution of efficiencies for each product class.* Prior to standards, not all shipments are at the baseline efficiency level. Higher efficiency products, such as those with ENERGYSTAR® ratings are sold even in the absence of standards. The prevailing efficiency distributions both with and without new standards in effect are critical in understanding how the market moves following standards, and hence how much energy is saved.

3. **Usage data**: These data contribute to the calculation of the annual unit energy consumption (UEC) of each product and include:

    a. *The UECs themselves or other efficiency ratings*. Various efficiency levels comprise the efficiency distribution. These levels include both a baseline efficiency level and one or more efficiency levels above the baseline. Each efficiency level corresponds to a different UEC. Sometimes, the UECs are reported directly at each level. More often, efficiency ratings are reported at each level. In this case, the efficiency ratings are combined with usage data to calculate the UECs.

    b. *Usage and duty cycle information*. Where UECs are not reported directly, usage and/or duty cycle data are needed to translate between an efficiency rating and the UEC. As an example, residential clothes dryers' efficiency levels are expressed as pounds of laundry dried per kilowatt hour. Both the average number of pounds per load and loads per year are required to calculate the UEC for residential clothes dryers.

4. **Stock model data**: The research team uses these data to generate the number of units in the region's installed stock, as well as the number retired and installed each year. These data include:

a. *Regional historical and forecast housing stock and commercial floor space.* These figures are used in conjunction with market saturation data to arrive at the installed stock in the turnover models.

b. *Market saturation*. Market saturation is simply the number of units per household or per square foot of commercial floor space of a given appliance. Recent and historic saturation data help identify trends in market adoption of appliances. These data form the basis of appliance stock when combined with regional historical and forecast housing stock and commercial floor space data.

c. *Product lifetime data.* Estimates of product lifetime help determine the useful life of an appliance before it requires replacement. These data drive stock turnover.

To collect these data, the team conducted a regional and national data assessment for each product selected in the screening process. While the best data sources varied by product, the key regional and national data sources include:

Regional Data:

1. Sixth Plan forecast and supply curves,
2. Regional Technical Forum (RTF) Unit Energy Savings (UES) measure workbooks,
3. Residential Building Stock Assessment (RBSA),
4. Commercial Building Stock Assessment (CBSA),
5. NEEA metering and equipment field studies, and
6. California Energy Commission appliance efficiency rulemaking staff analyses.

National Data:

1. DOE energy conservation standards rulemaking documents and their underlying data,
2. U.S. Energy Information Administration (EIA),
3. Appliance Standards Awareness Project (ASAP),
4. Association of Home Appliance Manufacturers (AHAM), and
5. The U.S. census.

All else equal, the research team prioritized use of regional data over national data for model inputs. However, sources varied in timeliness, comprehensiveness, and validity. The team relied heavily on the project's stakeholders to evaluate which data source to use, particularly whenever both national and regional data were available. When using national data the team adjusted parameters such as floor space and population, as necessary, to make it representative of the Northwest.

To facilitate the comparison of national versus regional sources, the team developed product-by-product "data forms," which maintained key data input values (e.g., baselines, lifetimes, duty cycles, etc.) and documented their sources. The team also documented these sources throughout the standards savings models themselves. Appendix C: Data Forms for Individual Products includes each product's data form, as well as the rationale for selecting one source over another, as applicable.

Modeling

Using the data outlined above, the research team developed models to quantify the Momentum Savings from appliance standards. The models quantify these savings by comparing appliance energy consumption between two cases: a "Pre-Case" and a "Post-Case". The Pre-Case aligns with the Sixth Plan assumptions of what standards are on the books or in effect at the time the plan was written. In this regard, the Pre-Case *does not* reflect the impact of standards announced after the Sixth Plan was published. In contrast, the Post-Case *does* reflect the impact of standards announced after the Sixth Plan was published. In either case, energy consumption is a product of appliance shipments and their unit energy consumption (UEC). Where shipments are held constant between the Pre-Case and Post-Case, the incremental savings come from the change in UEC between the Pre-case and Post-Case and are defined by the following equation:

$$Shipments \quad x \quad Change\ in\ UEC\ between\ Pre-Case\ and\ Post-Case \quad = \quad Incremental\ Savings$$

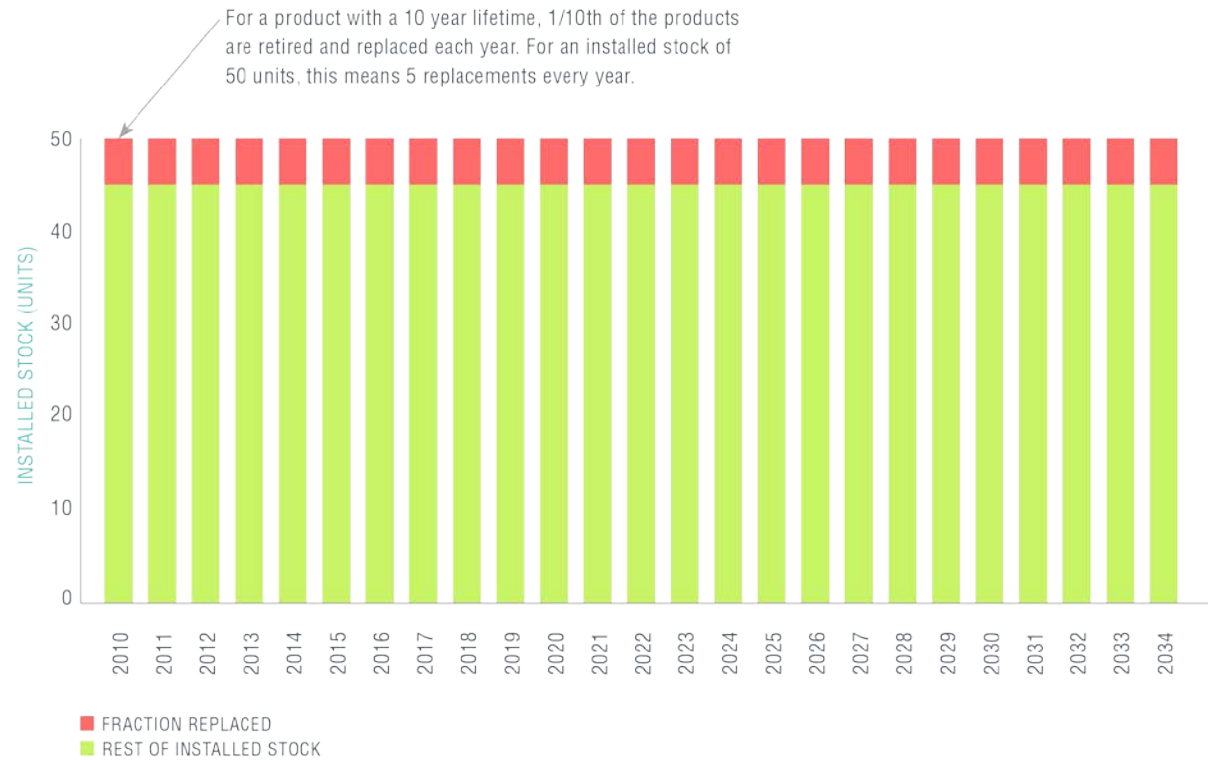
Shipments are derived from central stock turnover models whereas UECs are developed in individual appliance standards models. The following two sections describe these two types of models in greater detail.

Stock Turnover Models

Stock turnover models provide the shipments and installed stock projections needed to calculate incremental savings in the appliance standards models. A set of shipments and installed stock spanning the full analysis period from 1981 to 2034 is pulled from the stock turnover models into each appliance standards model by way of a link. The estimates of shipments and installed stock are based on appliance saturations (typically from the RBSA or CBSA), appliance lifetimes (typically from DOE standards rulemakings), and either a projection of housing stock (for residential products) or commercial floor space (for commercial products). Because of this last distinction, the research team developed two centralized stock turnover models: one for appliances in the residential sector, and one for appliances in the commercial sector.

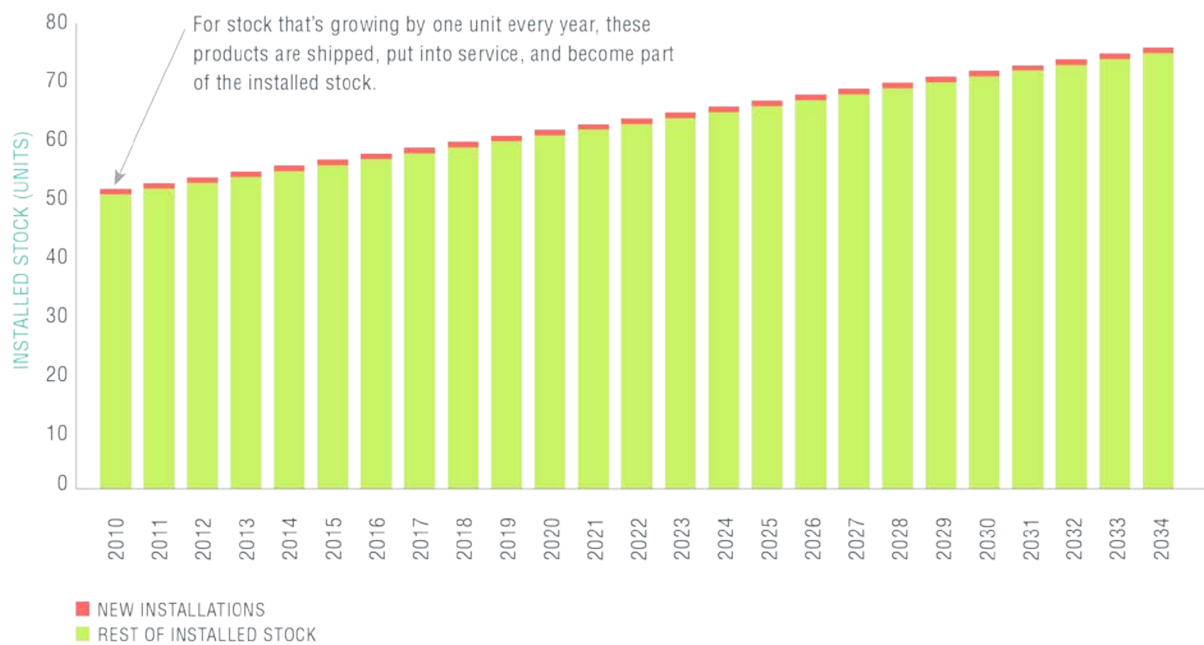
In either model, the installed stock of appliances in each year of the analysis is simply the product of the number of homes (or area of commercial floor space) and the appliance saturation in that year. The models then estimate the shipments in each year of the analysis by examining how the stock turns over and how it grows. Stock turnover is a function of the estimated useful life of a product. The models assume that products are shipped, put into service, and remain in the installed stock for their estimated useful life after which they are retired and replaced. As illustrated in Figure 1 absent any growth in stock, this means that in every year of the analysis, a fraction equal to one over the lifetime of the installed stock is retired and replaced.

Figure 1. Annual Fraction of Replacements (Assuming Constant Stock)



In contrast to stock turnover, stock growth is a function of new construction and/or increasing saturation, both of which represent completely new installations. New installations tied to new construction is exactly as the name suggests: an increase in housing stock or commercial floor space translates into more appliances in the stock. In contrast to new construction, new installations from increasing saturation simply means that there are more units per household or per square foot of commercial floor space. As illustrated in Figure 2, these new installations are shipped and contribute to growing the installed stock.

Figure 2. New Installations Grow the Installed Stock



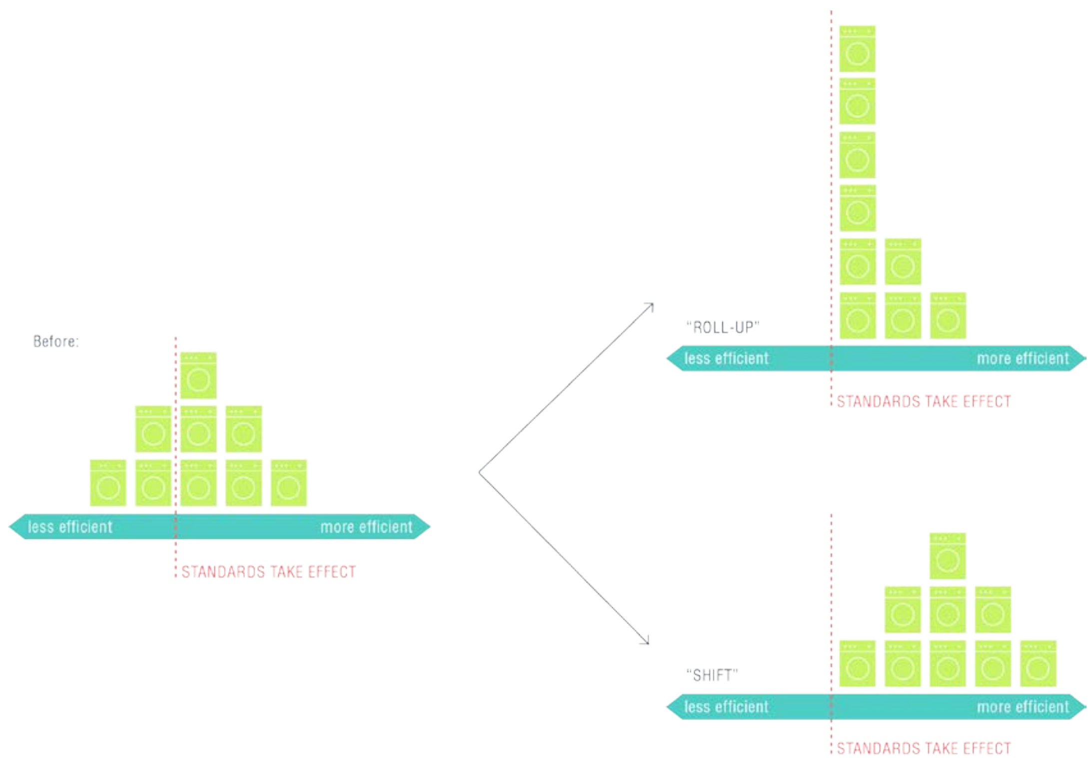
It is important to distinguish between replacement shipments and new installations when accounting for Momentum Savings as the two types of shipments contribute differently. This accounting is described in greater detail in *Savings Calculations*.

Appliance Standards Models

As mentioned, the two types of shipments, and installed stock are pulled into individual appliance standards models to calculate the Momentum Savings from standards. These models do so by combining the shipment data with UEC data. Unlike the shipments, the UECs are developed within the individual appliance standards models. UECs are a function of the market efficiency mix (typically from DOE standards rulemakings), the product mix (also typically from DOE standards rulemakings), and other usage characteristics (from regional specific studies, as available, or from DOE standards rulemakings). Because the efficiency mix, product mix, and usage characteristics are product specific, each appliance has its own standards model. As described in *Data Collection and Sources*, standards cover multiple classes of products, each with its own efficiency mix. A UEC is calculated for each efficiency level of each product class analyzed. The models then calculate weighted average UECs based on the mix of products and efficiencies in each year of the analysis.

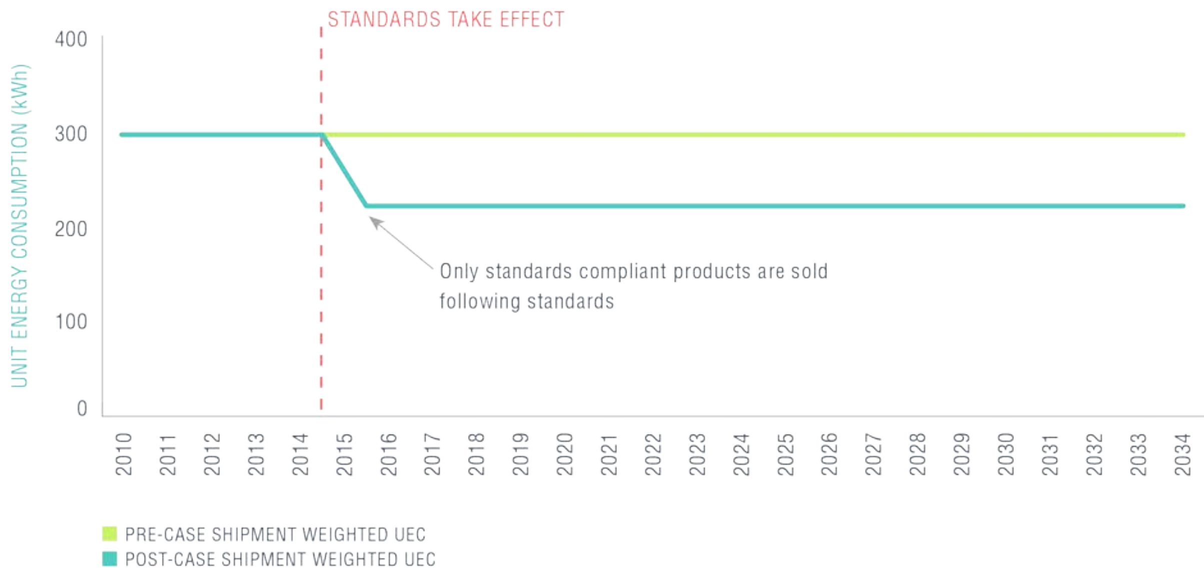
Recall from the introduction to *Modeling*, incremental savings come from the change in UEC between the Pre-case and Post-Case. In any model, the UEC is the same in either case leading up to standards. However, when standards take effect, they directly impact the efficiency mix in the Post-Case by eliminating the least efficient products from the market, and in turn change the Post-Case UECs. This change in efficiency distribution between the Pre-Case and Post-Case typically follows one of two patterns: a *roll-up*, or a *shift*. A roll-up models the situation in which the fraction of shipments which no longer comply with new standards, moves to meet the new minimum standard, but goes no higher. This represents the most conservative approach to modeling the impact of standards as it elicits the least change in UEC. In contrast, the shift maintains a similar distribution of shipments across various efficiency levels, but all efficiency levels are now above the new minimum standard. This reflects a greater change in UEC. To be conservative in the estimate of Momentum Savings, the appliance standards modeled in this project almost exclusively examine a roll-up of products following standards. Figure 1 provides an illustration of these two changes in efficiency distribution.

Figure 3. Efficiency Distributions Before and After Standards



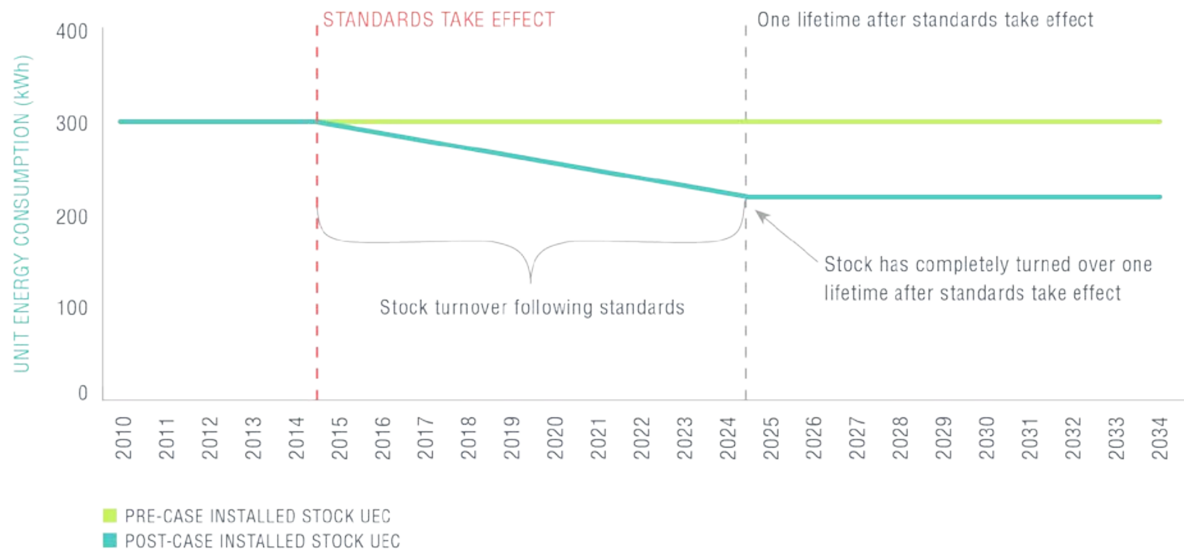
In addition to changing the efficiency mix, standards may also cause a change in product mix. This happens in instances where different products are adequate substitutes for one another. An example of this occurred with amended standards for residential clothes washers. Following standards, the price gap closed between less efficient (and traditionally less expensive) top-loaders and higher efficiency (traditionally more expensive) front-loaders. This change in pricing prompted a portion of the market to buy the now comparatively less expensive front-loaders – altering the product mix. Because of changes to either the efficiency mix, the product mix, or both; standards impact the weighted average UECs in the Post-Case. This change in shipment weighted UEC happens immediately following standards as manufacturers can no longer produce and sell non-compliant appliances, as illustrated in Figure 4.

Figure 4. Illustration of Pre-Case and Post-Case Shipment Weighted UEC



In contrast, the installed stock UECs change more gradually. This happens because the stock does not turn over in just one year – it takes the equivalent of one product lifetime. The installed stock grows more efficient following standards as older units retire and are replaced by higher efficiency standards compliant products. Once the stock has turned over completely, it ceases to grow more efficient as all the units comprising the installed stock before standards have already been replaced by higher efficiency alternatives as illustrated in Figure 5.

Figure 5. Illustration of Pre-Case and Post-Case Installed Stock Unit Energy Consumption



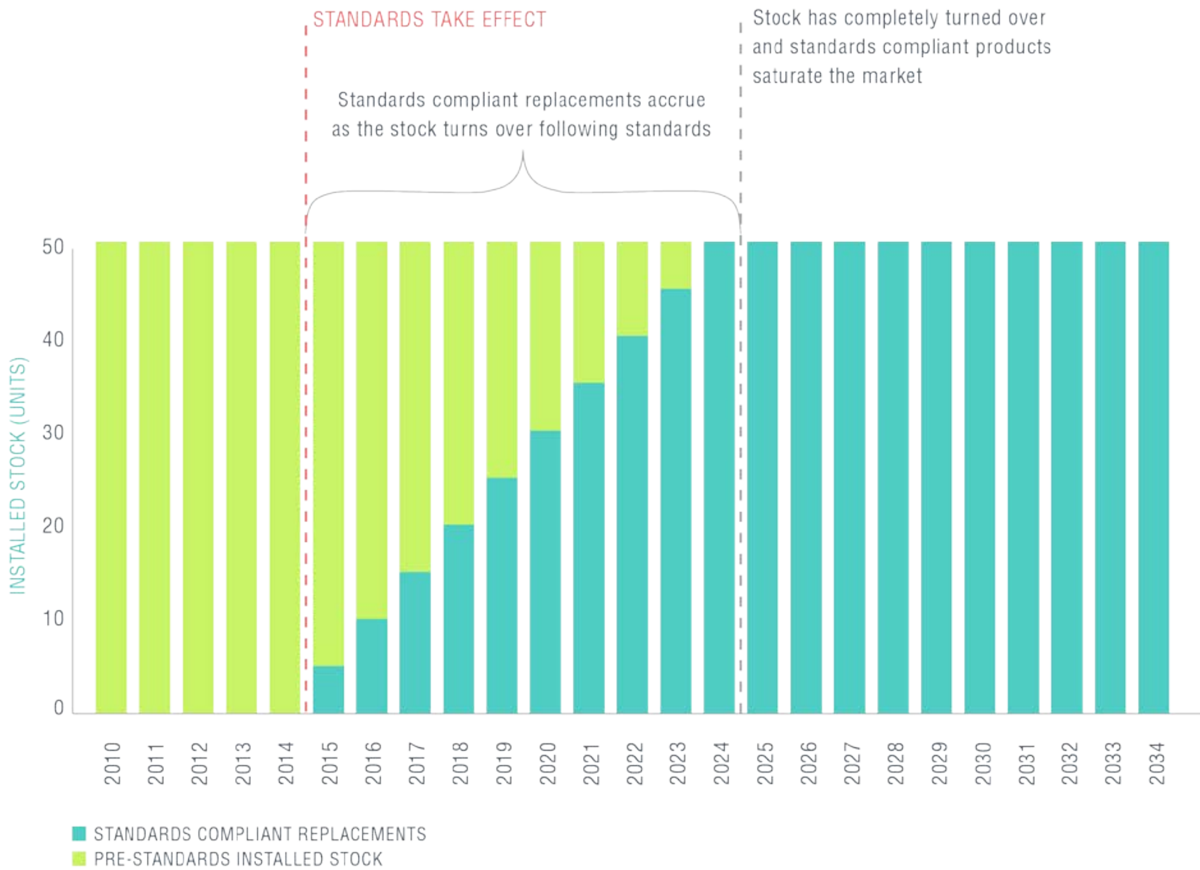
The difference between the UECs in the Pre-Case and Post-Case represents the opportunity for savings. One might think you could simply multiply the difference in shipment weighted UECs by the shipments in any given year to arrive at the incremental savings. However, this is not the case. Only certain shipments count towards savings. The next section discusses the accounting issues addressed in savings calculations.

Savings Calculations

As discussed in the 'Treatise on Savings,' energy savings must adhere to two primary criteria: they must be from an above-baseline measure, and they count only in the first year following installation. Comparing a Pre-Case which aligns with the Sixth Plan assumptions of standards to a Post-Case which includes the effect of new standards announced after the Sixth Plan helps establish what measures are above baseline. However, the accounting of which shipments count and when, is more complicated. Recall from *Stock Turnover Models*, that there are two types of shipments: replacements and new installations. Each contributes to savings in a different way.

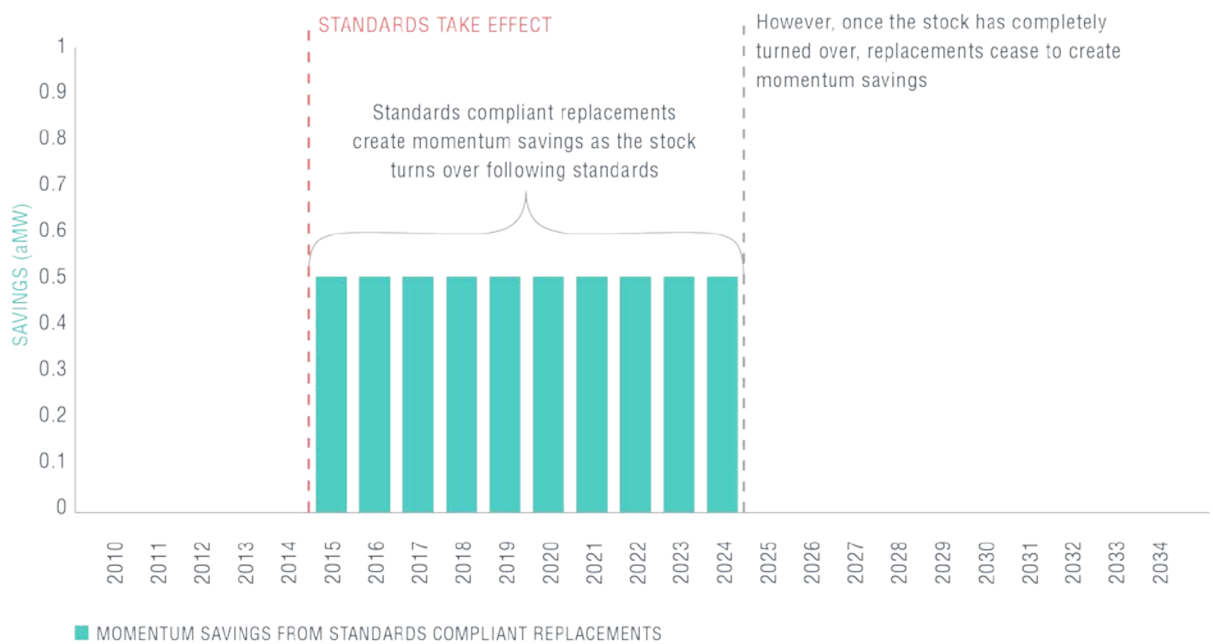
Replacements only count towards savings as the stock is turning over. During this period they are replacing units that were part of the installed stock before standards took effect. Once the stock has turned over it is entirely comprised of standards compliant products, and no more savings from replacements can be gained. This is because at this point and thereafter, there is no difference in energy consumption between the replacement unit and the retired unit it is replacing. Recall our earlier example in which an installed stock of 50 units is comprised of an appliance with an average lifetime of 10 years. This means that 5 units will fail and be replaced each year. Were a new standard to take effect in 2015, the newly standards compliant replacements would accrue in the stock until it had completely turned over by 2024, one product lifetime later, as illustrated in Figure 6.

Figure 6. Accumulated Replacements Following Standards



When standards compliant units replace part of the installed stock that predates standards – these units create savings. However, once the entire stock has turned over, replacement units cease to create savings as they are simply replacing similar standards compliant products. Figure 7 illustrates how replacement units create savings during stock turnover, and not thereafter.

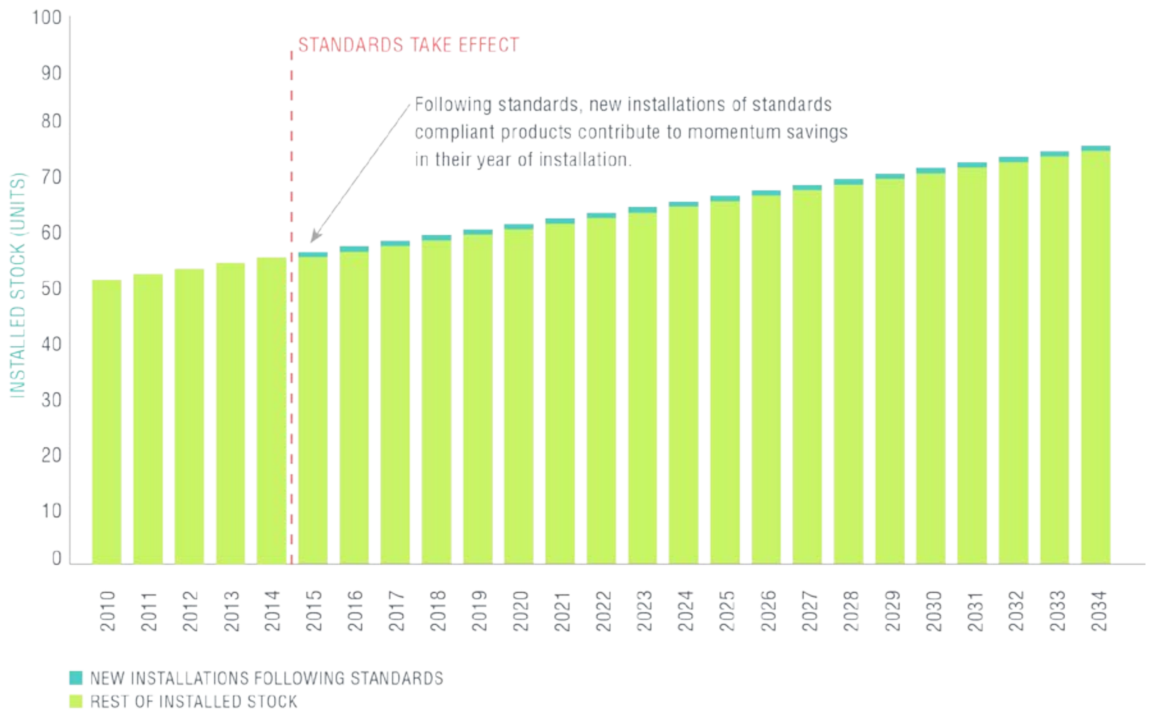
Figure 7. Momentum Savings from Replacement Shipments during Stock Turnover



In contrast to replacements, new installation shipments create savings even after the stock has turned over. This is because they are compared against what could have been installed, had new standards not taken effect. They are still only credited once – in the year they are shipped, but operate independently from stock turnover.

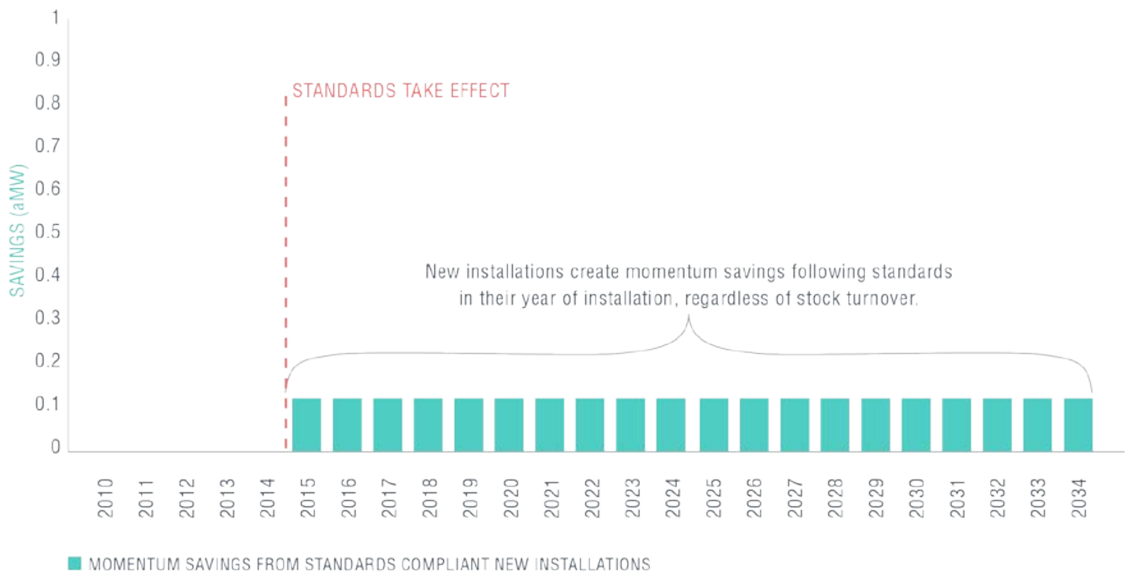
Recall that new installation shipments are the result of increasing market saturation or growing housing stock. If the installed stock starts at 50 units in 2010 and grows at a rate of 1 unit per year, the saturation will grow to 74 units by 2034 (over 25 years inclusive.) This means that one new installation per year is contributing to Momentum Savings following standards as illustrated in Figure 8.

Figure 8. New Shipments Create Savings Following Standards



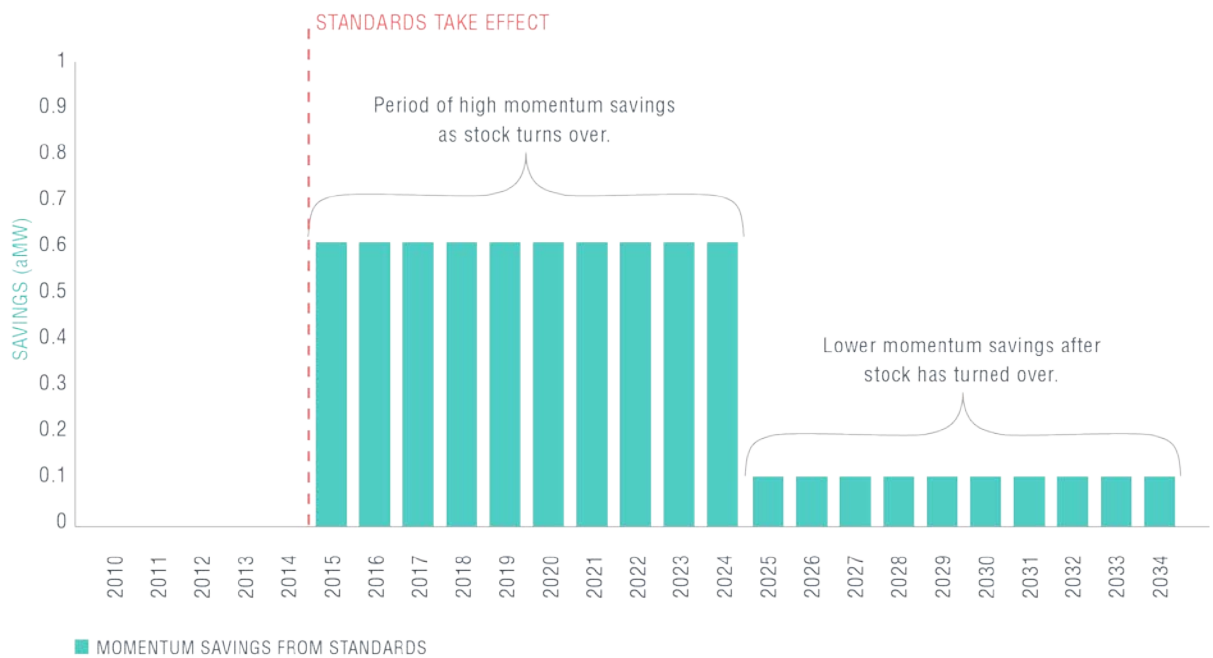
These units are not replacing anything, they are simply new stock. Accordingly, when calculating Momentum Savings, we compare them to the alternative products had standards not taken effect. As such, savings associated with new shipments continue to accrue independent of stock turnover. If these units also contribute 0.1 aMW of savings, the incremental savings from new installations would appear as it does in Figure 9.

Figure 9. Illustration of Incremental Savings from New Shipments



To recap, both replacements and new installations create Momentum Savings while the stock is turning over – a period lasting one product lifetime after standards take effect. However, only new installations generate savings after the stock has turned over, because after that point replacements are replacing already-standards compliant units. Adding the savings from replacement shipments to those arising from new installations produces the characteristic pattern of Momentum Savings from standards as illustrated in Figure 10.

Figure 10. Momentum Savings from Appliance Standards



Products/Equipment and Savings Aggregation

The research team combined the standards analysis results by sector, namely, the residential and the nonresidential sector. The team further breaks down the residential aggregated results into the three residential building types: single family, multi-family, and manufactured homes.

Similarly, the non-residential sector aggregated results can reflect savings across to seventeen commercial building types. The research team leveraged CBSA data to vary the saturation assumptions by building type when available. When CBSA is not available, the team developed saturation of the product by scaling DOE shipment data.

Products such as battery chargers, external power supplies, and small electric motors are applicable to residential, commercial, and industrial sectors. Due to the span of these products in all sectors, Navigant analyzed these products with stand-alone models. Thus, these models are not linked to the central residential or commercial models.

Results

This section presents the results from residential, non-residential, and cross-sector products. The results include the savings from both 2013 and 2014 analysis cycles to give a comprehensive picture of the impact of the analyzed standards. This section also shows the adjustments made to the Sixth Plan's forecast using up-to-date data which was unavailable at the time of the writing of the Plan.

Residential Sector Results

Table 2 displays the regional residential site savings and BPA residential sector site savings impact of the analyzed standards from 2010 to 2015 and from 2016 to 2034. The aggregated Momentum Savings due to standards before program adjustments of the analyzed products is 35.2 aMW (with line loss, or "busbar" accounted for) from 2010 to 2015 for the Pacific Northwest. Region-specific savings are 14.8 aMW (with busbar).

Table 2. Residential Standards-Induced Momentum Savings (aMW) with Busbar

Product	Region		BPA	
	2010-2015	2016-2034	2010-2015	2016-2034
Res Dishwashers	1.27	6.16	0.53	2.59
Res Refrigerators	7.53	125.34	3.16	52.64
Res Freezers	1.47	27.34	0.62	11.48
Res Clothes Washers	0.00	0.00	0.00	0.00
Res Water Heaters	14.20	186.20	5.96	78.21
Res Ceiling Fan Lighting Kits	3.75	4.63	1.58	1.94
Res Torchieres	2.91	1.21	1.22	0.51
Res Heat Pumps	1.44	27.34	0.60	11.48
Res Central Air Conditioners	0.02	0.34	0.01	0.14
Res Clothes Dryers	0.87	27.34	0.37	11.48
Res Electric Furnace Fans	0.00	85.36	0.00	35.85
Res Microwaves	0.00	4.42	0.00	1.86
Res Room Air Conditioners	0.30	1.21	0.13	0.51
Total Residential	33.77	496.89	14.18	208.69

Source: Navigant Analysis, 2015 - Note that clothes washers do not yield savings as the Sixth Plan captured the efficiency level of the standard.

Non-Residential Sector Results

Table 3 displays the regional commercial sector results of the analyzed standards from 2010 to 2015 and from 2016 to 2034. The total Momentum Savings from standards across the region is 49.66 aMW (with busbar). BPA's share of these savings is 20.86 aMW (with busbar). These values are for standards impacts alone and do not reflect any adjustments made for programs convering the analyzed products. The majority of the Momentum Savings from 2010-2015 comes from standards on distribution transformers while electric motors and walk-in coolers and freezers contribute significantly to Momentum Savings from 2016 onwards.

Table 3. Non-Residential Standards-Induced Momentum Savings (aMW) with Busbar

Product	Region		BPA	
	2010-2015	2016-2034	2010-2015	2016-2034
NonRes Clothes Washers	1.71	8.26	0.72	3.47
NonRes Illuminated Exit Signs	0.00	0.00	0.00	0.00
NonRes Pre-Rinse Spray Valves	0.00	0.00	0.00	0.00
NonRes Refrigeration Equipment	0.00	10.89	0.00	4.57
NonRes Walk-In Coolers and Freezers	2.23	50.79	0.94	21.33
NonRes Electric Motors	0.66	108.33	0.28	45.50
NonRes Distribution Transformers	44.93	318.85	18.87	133.92
NonRes Central Air-Conditioner (Air-Cooled)	0.00	0.20	0.00	0.08
NonRes Central Air-Conditioner (Water-Cooled)	0.01	0.06	0.00	0.03
Non-Res Packaged Terminal Air-Conditioning/Heat Pump	0.12	0.36	0.05	0.15
NonRes Automatic Commercial Icemakers	0.00	7.26	0.00	3.05
NonRes Beverage Vending Machine	0.00	0.00	0.00	0.00
Total Commercial	49.66	505.00	20.86	212.10

Source: Navigant Analysis, 2015

Several products have no standards-induced Momentum Savings above the Sixth Plan baseline:

- Pre-Rinse Spray Valves: The standard was included in the Fifth and Sixth Plans.
- Illuminated Exit Signs: This product was not included in the Sixth Plan because it was assumed to already be at or above the standard with negligible potential remaining.
- Beverage Vending Machine: The Sixth Plan accounted for the standard for this equipment in the baseline.

Cross-Sector Results

Battery chargers, external power supplies, and small electric motors are applicable to residential, and non-residential sectors. From 2010-2015, the region's Momentum Savings from these products sum to 33.26 aMW, of which 13.97 aMW savings is specific to BPA.

Table 4. Products Applicable to All Sectors Standards-Induced Momentum Savings (aMW) with Busbar

Product	Region		BPA	
	2010-2015	2016-2034	2010-2015	2016-2034
Battery Chargers	26.51	108.05	11.13	45.38
External Power Supplies	0.00	63.64	0.00	26.73
Small Electric Motors	6.76	58.42	2.84	24.53
Total Commercial	33.26	230.10	13.97	96.64

Source: Navigant Analysis, 2015

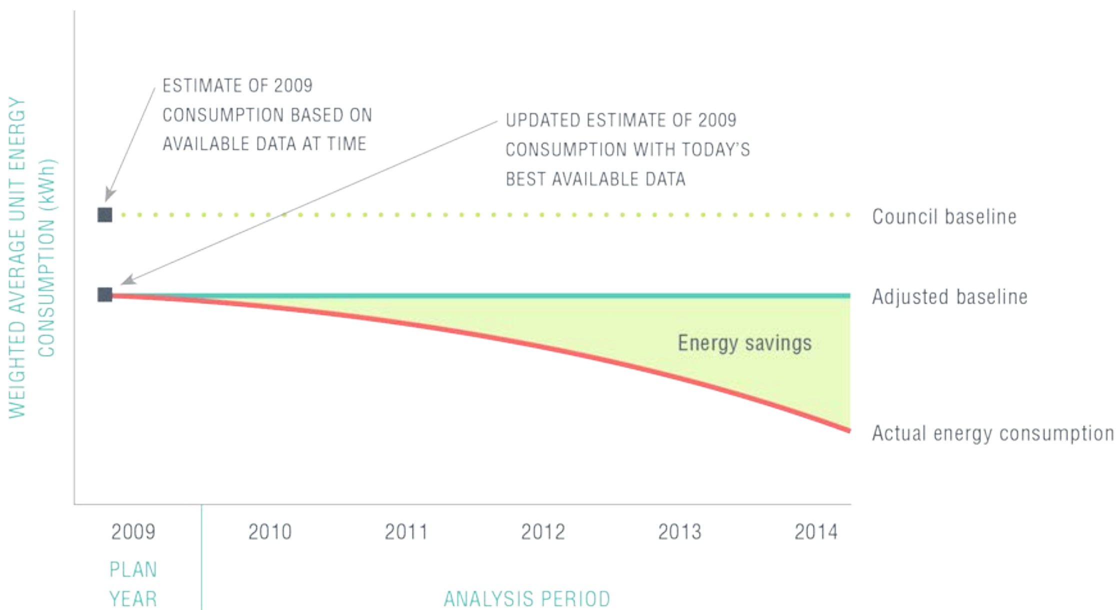
Baseline Adjustments

BPA estimates Momentum Savings, in part, to improve stakeholders' understanding of the full contribution of energy efficiency in meeting the region's energy needs, regardless of whether efficiency improvements result directly from programs. To demonstrate that the Momentum Savings from appliance standards are real (and substantial), analysis should measure savings against the most accurate baseline available. While the Council develops a baseline for each Power Plan based on the data available at the time, the passage of time often presents better, more complete baseline data. For instance, analysts and researchers may publish relevant market data (e.g., ENERGY STAR annual shipment data, NEEA's RBSA and CBSA studies, program evaluations, industry reports, etc.) just months after the Council finalizes the most recent Power Plan.

A baseline adjustment improves the accuracy of the Momentum Savings estimate while remaining consistent with the spirit of the Council baseline. The intent of the Council baseline is to accurately represent the average unit energy consumption (UEC) in a given market in the plan year. The plan year is the year prior to the years covered by the relevant Power Plan. For this Momentum Savings analysis, 2009 is the plan year for the Sixth Plan, which covers the years 2010 through 2015. The Council made the best possible estimate of the average UEC in 2009 with the data available when they prepared the Sixth Plan. However, 2009 market data collected after the publication of the Power Plan may indicate that the actual average UEC in 2009 was different than the Council's estimated baseline. In these cases, the Momentum Savings analyst may seek to adjust the baseline to more accurately reflect the average UEC in 2009. The "adjusted baseline" is the best possible estimate of the actual average UEC in the plan year, based on the data available now.

The baseline adjustment essentially "trues up" the Council baseline with the actual market conditions in the plan year, as shown in Figure 11. Since the adjusted baseline reflects the actual average UEC in the plan year, the adjusted baseline (which is frozen over time) and the trend line of actual average UEC as it changes over the analysis period originate from the same point on the graph. The change in actual average UEC over time reflects the changing efficiency mix. The space between the actual UEC trend line and the adjusted baseline in each year of the analysis period represent real energy savings.

Figure 11. Example of a Baseline Adjustment



Baseline adjustments may be up or down from the Council's original baseline. If the market proves less efficient than the Council expected in the plan year, then the adjusted baseline is higher than the Council baseline.

The research team adjusted baselines only under the following circumstances:

- If newer data sources (e.g., sales data) indicate that the actual efficiency mix[9] in the plan year is different than that used in the Council baseline, or

[9] Note that the efficiency mix may include substitutional goods that serve the same end use. For instance, the efficiency mix in the residential HVAC market includes two different products which serve the same purpose (forced air furnaces and air source heat pumps) as well as multiple efficiency levels within those product types. If newer sales data revealed that the forced air furnaces' share of residential HVAC sales in the plan year was higher than estimated in the Power Plan, the analyst would consider a baseline adjustment since forced air furnaces use more energy than air source heat pumps.

- If newer data sources (e.g., sales data) indicate that the product mix in the plan year is different than the plan baseline in instances when products are substitutional.

Baseline adjustments are not always possible. Newer, better data on the plan year's efficiency or product mix does not always exist. Similarly, the Council baseline may not explicitly report its assumed efficiency mix. Some cases may require assumptions about how to align the newer data with the Council's baseline. Any such assumptions will be caveated in the Momentum Savings methodologies.

Residential sector. Based on this methodology, the sum of all residential product baseline adjustments for the entire region was -3.64 aMW. BPA's share of this total is -1.53 aMW.

Table 5. Residential Products' Baseline Adjustments – Regional and BPA

Product	Regional Sixth Plan Baseline Adjustment (aMW)	BPA Sixth Plan Baseline Adjustment (aMW)
Residential Clothes Dryers	-0.18	-0.08
Residential Dishwashers	1.36	0.57
Residential Freezers	-0.06	-0.03
Residential Microwaves	-0.19	-0.08
Residential Refrigerators	-4.70	-1.97
Residential Room Air Conditioners	0.12	0.05
Total Residential Sector Adjustments	-3.64	-1.53

Source: Navigant Analysis, 2015

Commercial sector. The sum of the one-time baseline adjustments from the commercial products was 2.54 aMW for the region (and 1.07 aMW for BPA's share).

Table 6. Commercial Products' Baseline Adjustments – Regional and BPA

Product	Regional Sixth Plan Baseline Adjustments (aMW)	BPA Sixth Plan Baseline Adjustments (aMW)
NonRes Commercial Refrigeration Equipment	2.54	1.07
Total Commercial Sector Adjustments	2.54	1.07

Source: Navigant Analysis, 2015

Cross sector. There is no baseline adjustment for cross sector products.

Reconciliation with NEEA's Reports

Other programs and organizations in the region also track the markets of the products analyzed in this project. NEEA reports savings to BPA from several initiatives covering such products. Therefore, to ensure that savings are not double-counted, the totals claimable as standards in Table 8 exclude NEEA's values, as these savings are already accounted for in NEEA's reporting to BPA. Excluded products include:

- Residential Dishwashers
- Residential Clothes Washers
- Residential Clothes Dryers
- Cross-Sector Battery Chargers

Table 7 summarizes the residential and commercial results by year from 2010 to 2015 before subtracting NEEA's savings and overlap between standards and non-residential lighting momentum savings.

Table 7. BPA's Momentum Savings from Standards by Sector by Year (2010-2015) with Busbar

	2010	2011	2012	2013	2014	2015	Total
Residential	0.53	0.55	0.56	0.74	0.54	11.25	14.18
Non-Residential	3.38	3.4	3.32	3.54	3.59	3.62	20.85
Cross Sector	0	0	0	0	5.79	8.19	13.97
Lighting	0	1.37	6.87	9.62	9.16	6.87	33.89
Total	3.91	5.32	10.75	13.90	19.08	29.93	82.89

Source: Navigant Analysis, 2015

Table 8 summarizes BPA's claimable Momentum Savings and baseline adjustments, as well as the adjustments made for overlap between BPA standards lighting momentum savings and non-residential lighting momentum savings, and NEEA's reported savings.

Table 8. BPA's Momentum Savings from Standards and Baseline Adjustments for 2010-2015 with Busbar

	Momentum	Baseline Adjustment	Total
Residential	14.18	-1.53	12.65
Non-Residential	20.85	1.07	21.92
Cross Sector	13.97	0.0	13.97
Lighting	33.89	0.0	33.89
Total	82.89	-0.46	82.43
Less Reported by NEEA	-12.03	0.0	70.86
Less Lighting	-33.89	0.0	-33.89
Total Remaining Claimable	36.97	-0.46	36.51

Source: Navigant Analysis, 2015

Model Enhancements, Future Improvements, and Data Gaps

The following sections describe the research team's efforts to improve upon the appliance standards models in this round of analysis, areas that the team identified for future model improvements, and gaps in the analysis.

Enhancements to Models

The research team made improvements to the appliance standards models as part of the second iteration of this project. These upgrades include developing a common model structure, using standard naming conventions for tabs and variables, and using consistent color coding of tabs, variables, and calculated values. The models now also feature a navigation tab which provides an overview of how data flows throughout the model and contains embedded hyperlinks to navigate between tabs. Each tab also has a link back to the Navigation tab as well as a link to a Comments tab where reviewers may leave feedback, questions, and suggestions for the modeling team.

The team also made significant efforts to source the assumptions within the models, and document the quality of these sources. This allows the team and stakeholders to quickly identify aging assumptions, review model accuracy, and ensure the use of the best available data.

Future Improvements

While the models created during this second iteration of analysis effectively quantify energy savings from appliance standards, the research team realizes there is room for improvements to accuracy and ease of use, and suggests the following enhancements to future versions:

- **Disaggregation of central models by territory.** It is difficult for program managers to recreate the overall size of their territory since the model ties shipments and stock back to the central sector models. Adapting these central stock turnover models to disaggregate results to individual service territories may help program managers better understand the impact of momentum standards in their area and to design better programs. This is especially important for HVAC related standards, the impact of which may vary widely between climate zones across the region.
- **Additional commercial building equipment data by building type**. Energy consumption varies by building type in both residential and commercial sectors. There is considerable variation in saturation and usage data across different commercial and residential building types. Modeling impacts and forecasts by building type would allow greater insight into the composition of savings and the nature of existing potential, arming programs with better information for acquisition strategies. The team incorporated building level CBSA data to the appropriate standards models. However, the CBSA did not cover all commercial equipment analyzed in the standards project. Future commercial building primary data collection for equipment that were not in the scope of the CBSA 2014 could better inform standard model operating hours, saturation levels, turnover assumptions, and equipment types by building type.
- **Improved Saturation Projections.** Saturation is a key driver of stock growth and turnover. Where the central stock turnover models have only two points of historic saturations for each appliance, the current approach to modeling saturation over time is crude: linear interpolations between two points and constant values on either side of the window. This is fine for mature markets in which one would not expect much change in saturation over time. However, for new products and emerging technologies this approach is a poor fit. Incorporation of Bass diffusion models into saturation projections (both historic and future) where appropriate is one way to substantially improve the accuracy and realism of these numbers.
- **Turnover assumption research**. Each model's turnover assumption—the rationale used by the modeler to "retire" some of the installed stock each year—is the dominant driver of the models' annual shipment forecasts. To date, the models make the implicit assumption that products fail at a uniform rate. The suitability of this approach varies by product. For mature markets with slow steady growth, it is appropriate in most cases. For emerging technologies or for products of varying lifetimes, more sophisticated approaches using survival curves can be worth the extra effort to characterize the reality of non-uniform failure rates. The analyses could benefit from additional research comparing the two methods on savings impact and appropriateness.
- **Variable Input Scenarios.** In some instances, the team identified numerous sources of data some of which contradict each other. An example of this is residential clothes dryer usage, for which the NEEA field study and RBSA values disagree on the number of cycles per year. In future models, the team could allow for reviewers to examine multiple scenarios comprised of different, but credible data. This could in turn feed into sensitivity analysis within the model.
- **Sensitivity Analysis.** Much of the data used in these models is collected with enough statistical rigor that standard errors can accompany the mean values. The RBSA is particularly good at providing them and is cited throughout the analysis. Noting the ability to evaluate the sensitivity to these variables would help establish realistic bounds on estimated savings.

Data Gaps

The standards impact analysis model designs mirror, as closely as possible, the structure and assumptions made in the Sixth Plan potential assessment. The purpose of the Sixth Plan was to assess energy resource potential, and therefore focused on products and product classes thought to offer material potential. However, the DOE's NIA models provide more granularity on product classes and efficiency levels than did the Sixth Plan. Mapping to DOE assumptions would help improve the analytical rigor of the models created in this iteration of the project.

- **Residential Data Gaps: End-use load research for many residential products.** There is a lack of data regarding operating use, duty cycles, and load profiles for many residential products. Such data would greatly enhance the accuracy and rigor of the models as well as programmatic savings estimates. Only residential clothes dryers and central air conditioners use regional specific data (NEEA field and metering study and SEEM, respectively) in developing their UECs in this round of residential models. Residential models using DOE data include: cooktops, electric ovens, electric furnace fans, microwaves, and room air-conditioners. Load shape data would enable assessment of a broader set of demand-side management activities.
- **Non-residential Data Gaps: Electric Motors.** The CBSA does not have saturation data for electric motors by horse power distribution and by building type. The team estimated the saturation of electric motors by scaling DOE NIA data. Future data collection of electric motors distribution by horse power would help further customize the analysis for the region.

Additional Products Covered by Standards

Table 9 shows all regulated products not analyzed as part of this project cycle. Most of the products listed have small energy savings or primarily use gas.

Table 9. Additional Products Covered by Standards

Sector	Products
Residential	• Compact Audio Equipment • DVD Players and Recorders • Pool Pumps • Portable Electric Spas • Dehumidifiers • Residential Ceiling Fans • Pool Heaters • Residential Boilers • Direct Heating Equipment
Commercial/Industrial	• Water Dispensers • Hot Food Holding Cabinets • Commercial Warm Air Furnace • Commercial Water Heating Equipment • Commercial Package Boilers • Commercial Unit Heaters
Lighting	• Traffic Signals Modules and Pedestrian Modules

Source: Navigant Analysis, 2015

Appendix A: Acknowledgements

This work would not have been possible without the efforts of Carrie Cobb of BPA, who from the project's conception ensured it was enriched by the participation of many valuable contributors. Chief among those who lent their time, data, and expertise were Kevin Geraghty and Bonnie Watson from BPA, Tom Eckman, Charlie Grist, Tina Jayaweera, and Massoud Jourabchi of the Northwest Power and Conservation Council. The authors would also like to thank Christina Steinhoff of the Northwest Energy Efficiency Alliance.

Appendix B: Product Standards That Took Effect from 2005 to 2020

Table B-1. Product Standards

	Initial Federal Legislation	Last Standard Issued	Effective Date of Last Standard	Issued By
Residential				
Battery Chargers	EPACT 2005	None	None	N/A
Boilers	NAECA 1987	2007	2012	Congress
Central Air Conditioners	EPACT 1992	2011	2016	DOE
Compact Audio Equipment	None			
Cooking Ranges and Ovens	NAECA 1987	2009	2012	DOE
Dehumidifiers	EPACT 2005	2007	2012	Congress
Direct Heating Equipment	NAECA 1987	2010	2013	DOE
Dishwashers	NAECA 1987	2012	2013	DOE
DVD Players and Recorders	None			
External Power Supplies	EPACT 2005	2014	2016	DOE
Furnaces	NAECA 1987	2011 (revoked)	2013	DOE
Furnace Fans	None	2014	2019	DOE
Heat Pumps	EPACT 1992		2006	DOE
Microwave Ovens	NAECA 1987	2013	2016	DOE
Pool Heaters	NAECA 1987	2010	2013	DOE
Pool Pumps	None			
Portable Electric Spas	None			
Residential Ceiling Fans	EPACT 2005	2005	2007	Congress

	Initial Federal Legislation	Last Standard Issued	Effective Date of Last Standard	Issued By
Residential Clothes Dryers	NAECA 1987	2011	2015	DOE
Residential Clothes Washers	NAECA 1987	2012	2015	DOE
Residential Refrigerators and Freezers	NAECA 1987	2011	2014	DOE
Residential Room Air Conditioners	NAECA 1987	2011	2014	DOE
Residential Water Heaters	NAECA 1987	2010	2015	DOE
Commercial/Industrial				
Automatic Commercial Ice Makers	EPACT 2005	2014	2017	Congress
Commercial CAC and HPs (Air-Cooled, Large)	EPACT 1992	2010	2016	Congress
Commercial CAC and HPs (Air-Cooled, Small)	EPACT 1992	2008	2016	Congress
Commercial CAC and HPs (Air-Cooled, Very Large)	EPACT 1992	2010	2016	Congress
Commercial CAC and HPs (Water- and Evaporatively-Cooled)	EPACT 1992	2012	2013	DOE
Commercial Clothes Washers	EPACT 2005	2010	2018	DOE
Commercial Packaged Boilers	EPACT 1992	2009	2012	DOE
Commercial Pre-Rinse Spray Valves	EPACT 2005	2005	2006	Congress
Commercial Refrigeration Equipment	EPACT 2005	2014	2017	DOE
Commercial Warm Air Furnaces	EPACT 1992	2004		
Commercial Water Heating Equipment	EPACT 1992	2001	2003	DOE
Distribution Transformers: Liquid-Immersed and Medium-Voltage, Dry-Type	EPACT 1992	2007	2010	DOE
Distribution Transformers: Low-Voltage Dry-Type	EPACT 2005	2005	2007	Congress
Electric Motors	EPACT 1992	2014	2016	Congress
Hot Food Holding Cabinets	None			

	Initial Federal Legislation	Last Standard Issued	Effective Date of Last Standard	Issued By
Packaged Terminal AC and HP	EPACT 1992	2008	2012	DOE
Single Package Vertical Air Conditioners & Single Package Vertical Heat Pumps	EISA 2007	2009	2010	DOE
Refrigerated Beverage Vending Machines	EPACT 2005	2009	2012	DOE
Unit Heaters	EPACT 2005	2005	2008	Congress
Walk-In Coolers and Freezers	EISA 2007	2014	2017	Congress
Water Dispensers	None			
Lighting				
Candelabra & Intermediate Base Incandescent Lamps	None	2007	2012	Congress
Ceiling Fan Light Kits	EPACT 2005	2005	2007	Congress
Fluorescent Lamp Ballasts	NAECA 1988	2011	2014	DOE
General Service Fluorescent Lamps	EPACT 1992	2015	2018	DOE
General Service Incandescent Lamps	EISA 2007	2007	2012	Congress
High Intensity Discharge Lamps	not until 2017			
Illuminated Exit Signs	EPACT 2005	2005	2006	Congress
Incandescent Reflector Lamps	EPACT 1992	2015	2018	DOE
Medium Base Compact Fluorescent Lamps	EPACT 2005	2005	2006	Congress
Mercury Vapor Lamp Ballasts	EPACT 2005	2005	2008	Congress
Metal Halide Lamp Fixtures	EISA 2007	2014	2017	DOE
Torchieres	EPACT 2005	2005	2006	Congress
Traffic Signal Modules and Pedestrian Modules	EPACT 2005	2005	2006	Congress

Appendix C: Data Forms for Individual Products

Table C-1. Automatic Commercial Icemakers

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Usage						
Standard Effective Year	Year when standard takes effect	N/A	N/A. Existing BPA model and 6P baseline captured the previous standard with a 2010 standard effective year	2018		

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Pre-case Efficiency Distribution	Efficiency level in the 6P	Yes	100% of shipments are at 2010 standard level. Metric : kWh Self Contained Ice Makers <200lb : 2436 Self-Contained Ice Makers >=200 lb. : 7346 Not Self Contained Ice Makers : 8710 Energy Savings are based on Energy use (kWh/100 lb. of ice), Average Ice Harvest Rate and Duty Cycle;	Efficiency distributions span over 4-5 EL levels for each product class. See Market share tab	Efficiency distribution based on manufacturer surveys	PC_Packaged_Refrig_Equipment.xls LCC analysis - EERE-2010-BT-STD-0037-0060 NIA Model - EERE-2010-BT-STD-0037-0057
Post-case Efficiency Distribution	Efficiency level after standard took effect	N/A	N/A	2018 Standard corresponds to TSL 3; See standards tab	The previous standard was based only on Batch type Ice Makers. The new standard will also regulate Continuous type Ice Makers. Hence, there is an additional set of product classes for Continuous that we need to account for in this analysis.	DOE NIA Commercial Refrigeration Product workbook DOE NOPR Table I.1; TSD: 10.5.2 Results for the Adopted Standards

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Harvest (lbs. of ice/24 hours)			Varies by product classes, ranges from 101-1036 lbs. /24 hrs.	Varies by product classes, ranges from 50-2,500 lbs. /24 hrs.		PC_Packaged_Refrig_Equipment.xls LCC analysis - EERE-2010-BT-STD-0037-0060 NIA Model - EERE-2010-BT-STD-0037-0057
Market						
Number of product classes	Number of product classes	Yes	Three product classes	Four Equipment types - 32 product classes. See standards tab; 15 representative product classes. See Market share tab for product class distribution.	See Product Classes tab. Additionally, in the new standard, there is an addition of Continuous type Ice Makers to the previous Batch type.	PC_Packaged_Refrig_Equipment.xls; NIA Model - EERE-2010-BT-STD-0037-0057 DOE NOPR

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Shipments for ice-maker	Equipment shipment by year	N/A	Based on Appliance Magazine 2008 numbers. Calculated as follows: "Approximate Annual Sales in 2001" % * Average of 1998 to 2010 shipments (based on Appliance Magazine 2008 numbers)*PNW population % * shipment growth rate (based on CRE NIA Econ Trend)	Based on Commercial Square Footage year-on-year "growth" (hard coded number in CommercialRefrigerationEquipment_NIA_workbook) - new NIA model has data from 2013 Annual Energy Outlook		PC_Packaged_Refrig_Equipment.xls LCC analysis - EERE-2010-BT-STD-0037-0060 NIA Model - EERE-2010-BT-STD-0037-0057
Stock Model						
Shipment Growth Rate	Shipment growth rate based on forecast	No	Average at 1.35%.6P uses NIA analysis, therefore all shipment assumptions are the same	New equipment is driven by construction of new floor space and replacement units are replaced on a one-for-one basis		DOE TSD Chapter 10 shipment model; CRE_Final_Rule_NIA_Workbook

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Lifetime	Product Lifetime	N/A	10 years	8.5 years (NIA model)		DOE TSD Chapter 10 shipment model; PC_Packaged_Refrig_Equipment.xls

Table C-2. External Power Supplies

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Usage						
UEC	Unit energy consumption (accounts for hours of use per week and device efficiency)	Yes	6 kWh pre 2006, 2 kWh post 2006	Varies based on product class and CSL.	DOE more specific	Regional: Code write-up DOE: Calculated from DOE External Power Supplies 2014 Final Rule, Technical Support Document: National Impact Analysis Spreadsheet, 'Energy Split' tab, column D and 'EPS Inputs' tab, columns AH:AN
Hours per week	Hours of use per week in various operational modes, application states, and usage trends.	Yes	Unclear	Varies based on frequency of use and mode; accounted for in UEC values.	DOE more specific	DOE: DOE External Power Supplies 2014 Final Rule, Technical Support Document: Chapter 7: Energy Use Analysis
5P Baseline Device Efficiency	Fifth Plan baseline device efficiency tiers	Yes	0.983 (2006) (Unclear what units are)	Varies based on product class and CSL.	DOE more specific	Regional: Code write-up DOE: 10 CFR 430.32 (w)

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
6P Baseline Device Efficiency	Sixth Plan baseline device efficiency tiers	Yes	0.983*1.05 (2008-2034) (Unclear what units are)	Varies based on product class and CSL.	DOE more specific	Regional: Code write-up DOE: 10 CFR 430.32 (w)
2008 Standard Device Efficiency	Device efficiency after standard took effect	Yes	Unclear	Based on UEC. Varies based on product class.	DOE more specific	DOE: 10 CFR 430.32 (w)
2016 Standard Device Efficiency	Device efficiency after standard took effect	Yes	Not included	Varies based on product class.	DOE more specific	DOE: DOE External Power Supplies 2014 Final Rule, Technical Support Document: Chapter 5: Engineering Analysis
Market						
Pre-case product class distribution	Number of product class(s) and distribution if standard did not exist	Yes	No product class separations	Varies based on product class.	DOE more specific	Calculated from 2009 shipments in DOE External Power Supplies 2014 Final Rule, Technical Support Document: National Impact Analysis Spreadsheet, 'EPS Inputs' tab, column N. Calculation divided 'Product Class Totals' for each product class by the sum of the 'Product Class Totals' for all product classes.

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Post-case case product class distribution	Number of product class(s) and distribution factoring in the effective standard	Yes	No product class separations	NIA model does not assume a change in market share with standards.	DOE more specific	Calculated from 2009 shipments in DOE External Power Supplies 2014 Final Rule, Technical Support Document: National Impact Analysis Spreadsheet, 'EPS Inputs' tab, column N. Calculation divided 'Product Class Totals' for each product class by the sum of the 'Product Class Totals' for all product classes.
Pre-case efficiency level distribution	Efficiency distribution of each product class if standard did not exist	Yes	No product class separations	Varies based on product class.	DOE more specific	DOE External Power Supplies 2014 Final Rule, Technical Support Document: National Impact Analysis Spreadsheet, 'Inputs' tab, cells E78:K86
Post-case efficiency level distribution	Efficiency distribution of each product class factoring in the effective standard	Yes	No product class separations	Roll up assumption	DOE more specific	DOE: DOE External Power Supplies 2014 Final Rule, Technical Support Document: Chapter 9: Shipments Analysis, section 9.3.1 (page 9-3)

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Appliance Saturation	Saturation rate of external power supplies in the NW region	Yes	Sales volume in 2006: 198 million (times 4% for PNW)	Not included	Use 4% of DOE shipments for NW	Regional: Code write-up
Stock Model						
Historical Replacement Units Shipment in 2005	Number of external power supplies shipped to region in 2005	Yes	Not included	Varies based on product class.	DOE more specific	DOE External Power Supplies 2014 Final Rule, Technical Support Document: National Impact Analysis Spreadsheet, 'Inputs' tab, cells C52:C60
New Construction forecast	New construction forecast from 2005-2030	Yes	Not included	Based on population growth rate (0.75%)	DOE more specific	DOE External Power Supplies 2014 Final Rule, Technical Support Document: National Impact Analysis Spreadsheet, 'Inputs' tab, cells J52:J60
Product Lifetime	External Power Supply Product Lifetime	Yes	Not included	Varies based on product class.	DOE more specific	DOE External Power Supplies 2014 Final Rule, Technical Support Document: National Impact Analysis Spreadsheet, 'Inputs' tab, cells AA52:AA60

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Turnover assumption	Product retirement rate	Yes	Not included	Varies based on product class.	Used 1/lifetime in model for consistency across BPA models.	DOE External Power Supplies 2014 Final Rule, Technical Support Document: National Impact Analysis Spreadsheet, 'Inputs' tab, cells AB52:AP60

Table C-3. Commercial Beverage Vending Machines

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Usage						
Standard Effective Year	Standard Effective Year	No	2012	2012		DOE Final Rule published August 31, 2009
Pre-case efficiency distribution	Efficiency level in the 6P	Yes	Standard included in 6P but with the assumed standard level in the 6P is different from the final rule. The council assumed TSL 4 for Beverage Vending Machine products as the standard while the final rule is TSL 6 for Class A vending machines and TSL 3 for Class B machines. This has been corrected in the existing BPA models. Calculated using hard coded annual energy consumption (in Commercial Refrigeration Equipment analysis workbook - 2012 Assumptions tab B213-K216) and market share (market share based on 2010 shipment from ANOPR workbook).	N/A		PC_Packaged_Refrig_Equipment.xls

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Post-case efficiency distribution	Minimum Standard	Yes	100% at Level 4. Based on hard coded annual energy consumption (in Commercial Refrigeration Equipment analysis workbook) and market share. Existing BPA model updated post-case with the correct TSLs.	100% at TSL 6 for Class A and TSL 3 for Class B. See Standards tab. Calculated at TSL6 and TSL3 and based on hard coded energy consumption (in Commercial Refrigeration Equipment analysis workbook) and market share		DOE NIA Commercial Refrigeration Product workbook
Beverage Vending Machines Volume (cu.ft.)	Average volume of Beverage Vending Machines by Product Classes	No	Ranges from 17-34 cu.ft. UEC is calculated in Commercial Refrigeration Equipment analysis workbook from a hard coded number (sourced from ANOPR)	Ranges from 17-34 cu.ft. depending on configuration, document at equipment specification tab in model	Supply Curves and Standards Product Classes Volume are different	DOE Final Rule TSD Chapter 7 - Page 7-2, Table 7.2.1
Number of product classes	Number of product classes	No	Six Product Classes. Same as DOE	Six Product Classes	See Product Classes tab	1. 2009 DOE Direct Final Rule, Table I.1, VI.1 and VI.2

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Market						
Shipment for beverage machines	Equipment shipment by year	No	Historical shipments sourced from State of the Vending Machine Industry (2006) and National Automatic Merchandising Association. Data captured in ANOPR	Historical shipments sourced from State of the Vending Machine Industry (2006) and National Automatic Merchandising Association. Data captured in ANOPR and Direct Final Rule	Supply curves has shipment numbers from Beverage Vending Machines ANOPR.	
Stock Model						
Lifetime	Product Lifetime	Yes	Measure Life in Supply Curves is 14 years	Measure Life is 10 years		DOE Final Rule TSD Chapter 8 - Page 8-4, Table 8.1.1 PC_Packaged_Refrig_Equipment.xls MDataMeasEquip tab

Table C-4. Residential Clothes Dryers

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Usage						
Efficiency Levels (Typically this a baseline for the 6P and one higher level and for DOE it is a set of efficiency levels)	Combined Energy Factor is the Metric. Units are lbs./kWh	N/A	2 (not explicitly stated, so we assume it was baseline and a higher "measure" level")	DOE Standard +2.0 Standby: 3.55, DOE Standard +1.5 W Standby: 3.56, DOE Standard + 0.08 W Standby: 3.61, Gap Fill + 0.08W Standby: 3.73, Gap Fill + 0,08 W standby: 3.81, Gap Fill/Maximum Available + 0.08 W Standby 4.08, Heat Pump (Max-Tech) + 0.08! Standby: 5.42	Found regional distribution in ResSectorConAssmt_112509Summary, which said 0% above baseline.	2011-04-18_TSD_Chapter_7_Energy_Use_Analysis and ResSectorConAssmt_112509Summary from 6P
Washer Cycles per year	Average annual washing cycles	Yes, different from DOE	SF: 229, MF: 215.6, MH: 207.1 AVG: 224.3	283	Use RBSA 2012 value	RBSA 2012-Single Family/Multi-Family/Manufactured Housing
Percentage of washer loads that become dryer loads	Share of washer loads that become dryer loads	Yes, different from DOE	SF: 89.2%, MF: 91.6%, MH: 88.8%	95%	Use RBSA 2012 value	RBSA 2012-Single Family/Multi-Family/Manufactured Housing

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Dryer Loads	Dryer Loads	Yes, different from DOE	311	269	Use RBSA Laundry Field Study Data	2014 NEEA Dryer Field Study: Section 3.4.8. Loads per Year (page 38)
Test load size	Average dryer load	Yes, different from DOE	7.64	8.45	Use Regional Data	2015 NEEA Dryer Field Study: Appendix A5.2. Dryer Load Characteristics - Table 33. Dryer Load Characteristics DOE TSD Chapter 5. The average load weights for standard -size units range from 3.8 lbs. To 13.7 lbs. with a mean value of 8.45 lbs.

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Dryer UEC by Vintage	Dryer UEC by Vintage	Yes, different from DOE	1990-1994- (624.2),1995-1999- (721.7),2000-2004- (775.2),2005-2009- (832.8),Post 2009- (635.5),Total- (761.8)	n/a	Using historic UECs as run up to standard	2014 NEEA Residential Building Stock Assessment: Metering Study, Table 48. Annual Clothes Dryer Energy Use by Vintage
Market						
Pre-case product class distribution	Number of product class(es) and distribution if standard did not exist	Yes, different from DOE	1 product class: Electric, Standard (4.4 ft3 or greater capacity)	6 product classes in DOE.	6 product classes, but Electric, Standard (4.4 ft3 or greater capacity) is 97% of market	
Post-case case product class distribution	Number of product class(es) and distribution factoring in the effective standard	Yes, different from DOE	1 product class: Electric, Standard (4.4 ft3 or greater capacity)	6 product classes in DOE.	6 product classes, but Electric, Standard (4.4 ft3 or greater capacity) is 78% of market	

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Pre-case efficiency level distribution	Efficiency distribution of each product class if standard did not exist	Yes different from DOE	Baseline is 3.01 (which was the min standard in place at the time of the Plan (1994 standard) with 100% of shipments.	6 levels, see below	Year before standard	rulemaking GRIM
Post-case efficiency level distribution	Efficiency distribution of each product class factoring in the effective standard	Yes, different from DOE	Baseline is 3.01 (which was the min standard in place at the time of the Plan (1994 standard) with 100% of shipments.	6 levels, see below	Year after standard	rulemaking GRIM
Appliance Saturation	Saturation rate of residential clothes dryers in the NW region	Yes, different from DOE	RBSA: 98% (SF), 47% (MF), 95% (MH)	N/A	Use RBSA 2012 value	RBSA 2012-Single Family/Multi-Family/Manufactured Housing

Historical Replacement Units Shipment in 2005	Number of CD shipped to region in 2005	Not applicable	Using Sixth Plan		In central residential file	Sixth Plan
New Construction forecast	New construction forecast from 2005-2030	Not applicable	Using Sixth Plan		In central residential file	Sixth Plan
Product Lifetime	Residential Clothes Dryer Product Lifetime	Yes, different from DOE	14	16	Used DOE because most recent.	NW Council Supply Curve: Clothes Washers and Dryers - Single Family
Turnover assumption	Product retirement rate	Yes, different from DOE	1/lifetime		The 1/lifetime assumption is consistent with the council's modeling practice.	

Table C-5. Residential Microwaves

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Usage						
Efficiency Levels	(Typically this a baseline for the 6P and one higher level and for DOE it is a set of efficiency levels)	No, same as DOE		5 Efficiency levels	See data tab	2011-04-18_TSD_Chapter_8_Life-Cycle_Cost_and_Payback_Period_Analyses.pdf

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Standby Power level	W	No, same as DOE		Product Class 1: Baseline:4W, FEMP Procurement Efficiency Recommendation:2W, Gap Fill:1.5W, IEA 1-Watt program:1W, Max-Tech: 0.02W Product Class 2: Baseline: 4.5WW, Zero W Cooking Sensor: 3.7 W, Switch Mode Power Supply: 2.7W, Improved Relay Power Supply Design: 2.2W, Max-Tech (Automatic Power Down): 0.04W		TSD_Chapter_5_Engineering_Analysis
Annual Standby Mode Operating Hours	hours	No, same as DOE		8689		2009 Microwave Ovens final Rule TSD (Chapter 6)

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Annual Active Mode Operating Hours	hours	No, same as DOE		71		2009 Microwave Ovens final Rule TSD (Chapter 6)
Annual Standby Power Energy Consumption	kWh/year	No, same as DOE	Baseline: 17.4	Standard: Product Class 1: 8,6, Product Class 2: 19.1 (This is the first standard)		ResOven_MicrowaveFY09v1_0
Annual Cooking Energy Consumption	kWh/year	No, same as DOE	Baseline: 131	N/A		ResOven_MicrowaveFY09v1_0

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Annual Energy Use	kWh/year	No, same as DOE		PRODUCT CLASS 1: Baseline: 34.75, CSL1: 17.38, CSL2:13.03, CSL:8.69, CSL4:0.17 PRODUCT CLASS 2: Baseline: 39.10, CSL1: 32.15, CSL2: 23.46, CSL3:19.11, CSL4:0.35		2011-04-18_TSD_Chapter_8_Life-Cycle_Cost_and_Payback_Period_Analyses.pdf
Market						
Pre-case product class distribution	Number of product class(s) and distribution if standard did not exist	No, same as DOE		2 product classes: Microwave-ovens and countertop combination microwave ovens, and Built-in and over-the-range combination microwave ovens		DOE NIA spreadsheet

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Post-case case product class distribution	Number of product class(s) and distribution factoring in the effective standard	No, same as DOE		2 product classes: Microwave-ovens and countertop combination microwave ovens, and Built-in and over-the-range combination microwave ovens		DOE NIA spreadsheet
Pre-case efficiency level distribution	Efficiency distribution of each product class if standard did not exist	No, same as DOE	Baseline appears to be 4W for Product class 1 and 4.5W for Product class 2; 100% at baseline	DOE has efficiency distributions for the analyzed product classes in the "Data" tab		DOE NIA spreadsheet

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Post-case efficiency level distribution	Efficiency distribution of each product class factoring in the effective standard	No, same as DOE		DOE has efficiency distributions for the analyzed product classes in the "Data" tab		DOE NIA spreadsheet
Appliance Saturation	Saturation rate of Res Microwaves in the NW region	Yes, different from DOE	Sixth Plan: 100%	2005:89.3%		TSD_Chapter_3_Market_and_Technology_Assessment, ResOven_MicrowaveFY09v1_0
Stock Model						
Historical Replacement Units Shipment in 2005	Number of residential microwaves shipped to region in 2005	N/A	Using Sixth Plan			

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
New Construction forecast	New construction forecast from 2005-2030	N/A	Using Sixth Plan			2011-04-18_TSD_Chapter_8_Life-Cycle_Cost_and_Payback_Period_Analyses.pdf
Product Lifetime	Res Dishwasher Product Lifetime		15 years	9 years	Used DOE because most recent	
Turnover assumption	Product retirement rate		1/lifetime		The 1/lifetime assumption is consistent with the council's modeling practice.	

Table C-6. Residential Room Air Conditioner

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Usage						
Standard Year	Effective year of standard	N/A	N/A	2014		DOE 2011 DFR
Efficiency Levels (Typically this is a baseline for the 6P and one higher level and for DOE it is a set of efficiency levels)	Combined Energy Efficiency Ratio (CEER) (Btu/h-W)	N/A	2: A baseline and a higher measure level.	6 Product Classes Analyzed with between 4 and 6 Els depending on PC. 8000BTU/hr. baseline coincides with 6P.		2011-04-18_TSD_Chapter_7_Energy_Use_Analysis, EStarRoomACFY09v1_0

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Standby Energy Use	W	N/A	N/A	1.4	Based on the test data, DOE established a baseline standby/off mode power consumption level of 1.4 W. Sixth Plan did not consider stand by explicitly.	DOE TSD Chapter 5
Council's Baseline Assumption Sixth Plan	kWh/year	Yes, different from DOE	Baseline: 375kWh/ year	Depends on product classes (DOE analyzed 6)		EStarRoomACFY09v1_0

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Annual hours of use	Hours AC is in use/year	Yes, different from DOE	460	750	While the difference between national and regional values would be expected, we need to discuss with Council how to deal values.	2011-04-18_TSD_Chapter_7_Energy_Use_Analysis, EStarRoomACFY09v1_0

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Pre-case product class distribution	Number of product class(s) and distribution if standard did not exist	No, same as DOE	For the Sixth Plan supply curve, they used an average capacity, based on AHAM national sales weighted average from 2007 (8500 btu/hr.)	16 Product Classes in DOE; consolidating to 6 for simplicity and because DOE only analyzed 6.	Using DOE because it is more recent (2011).	2011-04-18_TSD_Chapter_9_Shipments_Analysis (2)

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Post-case case product class distribution	Number of product class(s) and distribution factoring in the effective standard	No, same as DOE	Same as above.	16 Product Classes in DOE; consolidating to 6 for simplicity and because DOE only analyzed 6.	Using DOE because it is more recent (2011).	2011-04-18_TSD_Chapter_9_Shipments_Analysis (2)
Pre-case efficiency level distribution	Efficiency distribution of each product class if standard did not exist	Yes, different from DOE	N/A	DOE has efficiency distributions for the analyzed product classes in the efficiency distributions tab	Year before standard	rulemaking GRIM

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Post-case efficiency level distribution	Efficiency distribution of each product class factoring in the effective standard	Yes, different from DOE	N/A	DOE has efficiency distributions for the analyzed product classes in the efficiency distributions tab	Year after standard	rulemaking GRIM
Appliance Saturation	Saturation of Res Room AC in PNW	Yes, different from DOE	RBSA 2012: SF: 15.7%, MF: 34.8%, MH: 34%	N/A	Use RBSA 2012 value	RBSA 2012-Single Family/Multi-Family/Manufactured Housing
Stock Model						
Historical Replacement Units Shipment in 2005	Number of room AC units shipped to region in 2005	Not applicable	Using Sixth Plan			

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
New Construction forecast	New construction forecast from 2005-2030	Not applicable	Using Sixth Plan			
Product Lifetime	Room AC Product Lifetime	Yes, different from DOE	9	10.5	Used DOE because most recent	
Turnover assumption	Product retirement rate	Yes, different from DOE	1/lifetime		The 1/lifetime assumption is consistent with the council's modeling practice.	

Table C-7. Small Electric Motors

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Standard Effective Year	Year when standard comes into effect	N/A	N/A	2015	2010 rulemaking indicates that 2015 is the effective year	N/A
Usage						
Product Classes	Number and distribution of product classes	N/A	N/A	Polyphase motors, capacitor-start induction-run (CSIR) motors, capacitor-start capacitor-run (CSCR) motors	There are 62 total product classes, classified by pole configuration (2, 4 or 6), motor type (polyphase, CSIR or CSCR) and horsepower rating (range between 0.25 - 3 HP). Only open construction motors with the abovementioned product classes are covered by this standard.	N/A

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Annual Energy Consumption	DOE calculated average annual energy use by efficiency level	N/A	N/A	Various values from 858 to 2310 kWh/year for the three motor types at different efficiency levels	Uses shipment-weighted distribution of product class shipments to determine weighted average energy use per unit	N/A
Pre-case efficiency level	Pre-standard efficiency level	N/A	N/A	Polyphase 75.3%, CSIR 57.9%, CSCR 71.4%	These are the baseline efficiencies for the three demonstrated product classes	N/A
Post-case efficiency level	Post-standard efficiency level	N/A	N/A	Polyphase 83.5% (EL 5), CSIR 77.6% (EL 7), CSCR 81.7% (EL 3)	Standards require polyphase motors, CSIR and CSCR motors to meet average full load efficiency levels as specified in the Code of Federal Regulations, 10 CFR 431.446	N/A

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Market						
Pre-case efficiency distribution	Efficiency distribution of each product class if standard did not exist	N/A	N/A	Polyphase 54%, CSIR 40%, CSCR 37% baseline	Full distribution contained in model for three product classes at all efficiency levels	N/A
Post-case efficiency distribution	Efficiency distribution of each product class factoring in the effective standard	N/A	N/A	Polyphase 97% at EL 5 (or 4b), CSIR 100% at EL 7, CSCR 85% at EL 3	Modified TSL 4b for polyphase, modified TSL 7 for CSIR (EL 7) and CSCR (EL 3).	N/A
Shipment by Product Class	Motor shipments by HP class	N/A	N/A	DOE estimated shipments available for 2008: 750,000 polyphase, 3,100,000 CSIR, 163,158 CSCR	Shipment data is available for 2000 NEMA and can be used to backcast shipment data for the years between 2000 and 2008	N/A

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Shipment Growth Rate	Sales Growth Estimate	N/A	N/A	Reference scenario: 1.83%	DOE provides shipment growth scenarios for each product class	N/A
% Sales Applicable to Standards	Percentage of motor sales affected by the standard	N/A	N/A	100%	DOE only forecasted shipments for small electric motors that were covered under this rulemaking	N/A
Stock Model						
Lifetime	Product lifetime	N/A	N/A	Polyphase motors (9 years), CSIR motors (7 years), CSCR motors (7 years)	Since the different product classes have different lifetime values, each product class has its own stock model	N/A
Product Turnover Assumption	Stock Turnover Rate	N/A	N/A	Weibull distribution	This model uses a replace upon lifetime assumption for the stock turnover model for simplification.	N/A

Table C-8. Residential Central Air Conditioner

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Usage						
Efficiency Levels	Efficiency distribution of each product class if standard did not exist	No	N/A	13-17 in 0.5 SEER increments.	These were used along with the national shipments to create a shipment weighted SEER in both the Pre-Case and Post-Case	DOE GRIM
Efficiency Levels	Efficiency distribution of each product class if standard did not exist	No	N/A	13-24.5 in 0.5 SEER increments.	These were used along with the national shipments to create a shipment weighted SEER in both the Pre-Case and Post-Case	DOE GRIM

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Efficiency Levels	Efficiency distribution of each product class if standard did not exist	No	N/A	13-16.5 in 0.5 SEER increments.	These were used along with the national shipments to create a shipment weighted SEER in both the Pre-Case and Post-Case	DOE GRIM
Historical Efficiency Levels	(All efficiency levels in SEER) Baseline device efficiency tiers	Yes	SF - 10.3 SEER for 1990-1999; 10.9 SEER for 2000-2005, 13.4 for 2006 and later MH - 10.4 SEER for 1990-1999; 10.1 SEER for 2000-2005, 13.0 for 2006 and later	N/A	Based on vintage of unit	RBSA
Efficiency Levels	Shipment Weighted SEER	No	n/a	10-15 SEER based on DOE shipment weighted average	Calculated from DOE shipment data	

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Efficiency Levels	UEC at Various SEER Ratings	Yes	Varies by Cooling Zone: 10 SEER CZ1: 499, CZ2 1110, CZ3 2017 11 SEER CZ1: 464, CZ2 1041, CZ3 1901 12 SEER CZ1: 430, CZ2 972, CZ3 1784 13 SEER CZ1: 395, CZ2 903, CZ3 1668 14 SEER CZ1: 355, CZ2 812, CZ3 1508 15 SEER CZ1: 316, CZ2 721, CZ3 1348	N/A	Values extracted from the Single Family Representative Building Types in Simplified Energy Enthalpy Model (SEEM)	DOE TSD
Market						
Pre-case efficiency level distribution	Efficiency distribution of each product class if standard did not exist	No	N/A	Varies by Year (Annual Market Average SEER generated from DOE Shipment Data)	Developed from Efficiency Levels and DOE shipments in the Pre-Case	DOE TSD

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Post-case efficiency level distribution	Efficiency distribution of each product class factoring in the effective standard	No	N/A	Varies by Year (Annual Market Average SEER generated from DOE Shipment Data)	Developed from Efficiency Levels and DOE shipments in the Post-Case	DOE TSD
1992 Appliance Saturation	Saturation rate of CAC in the NW region	Yes	9.4%; 1.3%; 7.5%	N/A	Saturations for SF, MF, MH, respectively. DOE model does not break out saturation by building type	PNWRES'92
2011 Appliance Saturation	Saturation rate of CAC in the NW region	Yes	16.9%; 2.3%; 13.5%	N/A	Saturations for SF, MF, MH, respectively. DOE model does not break out saturation by building type	RBSA

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Cooling Zone Housing Allocation	% of Housing (SF and MH) in each cooling zone	Yes	SF CZ1: 64.3%, CZ2: 25.3%, CZ3: 10.4% MH CZ1: 63.4%, CZ2: 24.9%, CZ3: 11.7%	N/A	Housing Allocations extracted from raw RBSA data	RBSA
Stock Model						
Product Lifetime	Saturations tab in central residential model	Yes	19.5 years	20 years		DOE TSD, Sixth Plan

Table C-9. Residential Cooktops

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Usage						
1996 Level	Cooking Efficiency		N/A	0.679	Baseline device efficiency tiers	DOE TSD
2009 Levels	Cooking Efficiency		N/A	.679 - .746	Incremental efficiency tiers in DOE analysis (efficiency factor)	DOE TSD
Cooking Energy	Electrical energy required for cooking		N/A	240.7-280.6	in kWh/yr. for different efficiency levels	DOE TSD
1996 Level	Baseline device efficiency tiers		N/A	0.674		DOE TSD

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
2009 Levels	Incremental efficiency tiers in DOE analysis		N/A	.674-.704	Cooking efficiency for different efficiency levels (efficiency factor)	**DOE TSD**
Cooking Energy	Electrical energy required for cooking		N/A	246.0-256.7	in kWh/yr. for different efficiency levels	**DOE TSD**
Market						
Pre-case product class distribution	Number of product class(s) and distribution if standard did not exist		N/A	DOE GRIM Model	These are from the DOE NIA	**DOE TSD**

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Post-case case product class distribution	Number of product class(s) and distribution factoring in the effective standard		N/A	DOE GRIM Model	These are from the DOE NIA	**DOE TSD**
Pre-case efficiency level distribution	Efficiency distribution of each product class if standard did not exist		N/A	DOE GRIM Model	These are from the DOE NIA	**DOE TSD**
Post-case efficiency level distribution	Efficiency distribution of each product class factoring in the effective standard		N/A	DOE GRIM Model	These are from the DOE NIA	**DOE TSD**
Appliance Saturation	Saturation rate of Ovens in the NW region		75.1; 96.9; 88.9%		DOE model does not break out by building type	SF/MF/MH RBSA

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Pre-case product class distribution	Number of product class(s) and distribution if standard did not exist		N/A	DOE GRIM Model	These are from the DOE NIA	**DOE TSD**
Post-case case product class distribution	Number of product class(s) and distribution factoring in the effective standard		N/A	DOE GRIM Model	These are from the DOE NIA	**DOE TSD**
Pre-case efficiency level distribution	Efficiency distribution of each product class if standard did not exist		N/A	DOE GRIM Model	These are from the DOE NIA	**DOE TSD**
Post-case efficiency level distribution	Efficiency distribution of each product class factoring in the effective standard		N/A	DOE GRIM Model	These are from the DOE NIA	**DOE TSD**
Appliance Saturation	Saturation rate of Ovens in the NW region		75.1; 96.6; 88.9%			SF/MF/MH RBSA
Stock Model						
Product Lifetime	Residential Ovens Spreadsheet Cooking Eff Tab		N/A	13 years	no 6th Plan value	**DOE TSD**

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Product Lifetime	Residential Ovens Spreadsheet Cooking Eff Tab		N/A	13 years	no 6th Plan value	**DOE TSD**

Table C-10. Commercial Clothes Washer

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Regional Data Source	DOE Data Source
Usage							
Cycles per Year	Average annual washing cycle	Only DOE value available	2190	2190	DOE Commercial Clothes washers NIA, assumption for laundromat	NW Council Supply Curve: EStarWasher_DryerComLaundry_FY09v1_0	DOE Commercial Clothes washers NIA
Washer Capacity	Average clothes washer size	Commercial washer size available in the MF sector	2.83 cu.ft	2.83 cu.ft	DOE Commercial Clothes washers NIA	NW Council Supply Curve: EStarWasher_DryerComLaundry_FY09v1_0	DOE Commercial Clothes washers NIA
Water Heating Fuel Share	DHW heating market share by fuel type	Yes, different from DOE	64% electric	20% electric	Regional water heating fuel share is used	NW Council Supply Curve: EStarWasher_DryerComLaundry_FY09v1_0	DOE Commercial Clothes washers NIA
Clothes Dryer Fuel Share	Clothes dryer market share by fuel type	Yes, different from DOE	82% electric	40% electric	Regional water heating fuel share is used	NW Council Supply Curve: EStarWasher_DryerComLaundry_FY09v1_0	DOE Commercial Clothes washers NIA

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Regional Data Source	DOE Data Source
6P Baseline device efficiency	Sixth Plan device efficiency tiers	Commercial washer efficiency tiers available in the MF sector	2 efficiency levels; 1.04 MEF 2005-2006; 1.26 MEF 2007-2030	5 efficiency levels for front loading, and 3 levels for top loading	DOE has more efficiency tiers and product classes	Sixth Plan model code write-up sent to Navigant from the NW Council in 2013.	DOE Commercial Clothes washers NIA
Standard device efficiency	Device efficiency after standard took effect	Commercial washer efficiency tiers available in the MF sector	N/A	2.0 MEF front loading; 1.6 MEF top loading	current values are up to date; the 2012 standard was not included in the council's forecast	N/A	DOE Commercial Clothes washers NIA
Market							

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Regional Data Source	DOE Data Source
Base case product class distributio n	Number of product class(s) and distribution if standard did not exist	Yes, different from DOE	1 product class with the same MEF	2 product classes with different MEF's ; 30% Front Loading and 70% Top loading		N/A	DOE Commercial Clothes washers NIA
Standard case product class distributi on	Number of product class(s) and distribution factoring in the effective standard	Yes, different from DOE	Not applicable since the 2012 was not included in the 6P baseline	2 product classes with different MEF's; 30% Front Loading and 70% Top loading		N/A	DOE Commercial Clothes washers NIA
Base case efficiency level distributi on	Efficiency distribution of each product class if standard did not exist	Yes, different from DOE	100% at 1.04 MEF 2005-2006; 100% at 1.26 MEF 2007-2030	70% at 2012 standard efficiency level for front loading; 2% at 2012 standard efficiency level for top loading		N/A	DOE Commercial Clothes washers NIA

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Regional Data Source	DOE Data Source
Standard case efficiency level distribution	Efficiency distribution of each product class factoring in the effective standard	Only DOE analysis available	Not applicable since the product was not included in the commercial sector	100% at standard level	100% compliance at standard effective year	N/A	DOE Commercial Clothes washers NIA
Stock Model							
Historical Replacement Units Shipment in 2005	Number of CCW shipped to region in 2005	Yes, different from DOE	Data from Supply Curve, MF sector	Not applicable		PNW Residential Sector Load Forecast Copied from PNWResSectorSupplyCurveUnits_Sixth_Fnl workbook	DOE Commercial Clothes washers NIA
New Construction forecast	New construction forecast from 2005-2030	Only DOE analysis available	Data from Supply Curve, MF sector	Not applicable		PNW Residential Sector Load Forecast Copied from PNWResSectorSupplyCurveUnits_Sixth_Fnl workbook	DOE Commercial Clothes washers NIA

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Regional Data Source	DOE Data Source
Product Lifetime	CCW product lifetime	Yes, different from DOE	14	7.13	Using DOE lifetime because it is more robust	NW Council Supply Curve: EStarWasher_DryerComLaundry_FY09v1_0	DOE Commercial Clothes washer NIA
Turnover Assumption	Retirement Rate	Yes, different from DOE	1/lifetime	Survival curve based on Weibull distribution	This analysis takes the DOE model and scale it by regional floor space. Therefore, keeping the original turnover assumption.	NW Council Supply Curve: EStarWasher_DryerComLaundry_FY09v1_0	DOE Commercial Clothes washers NIA
Abandon Rate	Retired units not replaced	Yes, different from DOE	0%	12%	The council's baseline did not account for abandon rate	N/A	DOE Commercial Clothes washers NIA

Table C-11. Commercial Refrigeration Equipment

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Usage						
Standard Effective Year	Standard Effective Year	N/A	The 6P included the 2010 and 2012 standards	2017		DOE 2014 Commercial Refrigeration Equipment Final Rule, Technical Support Document Chapter 2: Analytical Framework, page 2-9
5P pre-case efficiency distributio n	Efficiency distribution level at 2005	No	100% at TSL level 1	100% at TSL level 1	No difference	DOE NIA Commercial Refrigeration Product workbook

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
6P Pre-case efficiency distribution	Efficiency level distribution in the 6P	N/A	The 6P Supply curve used the 2010 and 2012 standards as the baseline for the CRE products for 100% of shipments. See Standards tab; UEC weighted by shipment	N/A		PC_Packaged_Refrig_Equipment.xls
Post-case efficiency distribution	Efficiency level distribution	N/A	N/A	Varies by product class.	See Standards tab in this spreadsheet.	DOE 2014 Commercial Refrigeration Equipment Final Rule, National Impacts Analysis Spreadsheet, Market Share Inputs tab (entire tab)

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
UEC	Unit energy consumption	Yes	Sourced from cre_nopr_tsd_cp_6.pfd whereas the Non-hybrid products UEC were calculated using numbers sourced from Navigant (industry test measurement)	Varies by product class.	Change model to account for the new product classes.	PC_Pack_Refrig_Equip_6P_D3 DOE 2014 Commercial Refrigeration Equipment Final Rule, National Impacts Analysis Spreadsheet, LCC Inputs tab, cells B3:J29
Market						
Number of product classes	Number of product classes	No	ref &frz- 6 product classes ; non-hybrid ref-frz- 15 product classes	49 total product classes in 2017 standard	See product classes tab in this spreadsheet.	PC_Packaged_Refrig_Equipment.xls; DOE 2014 Final Rule

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Shipment for non-hybrid products	Shipment by year for replacement and new units	No	Supply Curves has no regional value. Use 2008 appliance magazine value and scale to region with 4%. Also used ARI, No. 7 Exhibit B at p. 1.	New standard used several different sources: 2005 shipments data provided by the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) as part of its comments to the 2009 rulemaking Framework document (Docket No. EERE-2006-STD-0126, ARI, No. 7,	Model updated and changed to account for the new product classes.	DOE CRE TSD Chapter 9 shipment model; CRE_Final_Rule_NIA_ Workbook

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Shipment for ref and frz products	Equipment shipment by year	N/A	Supply Curves has no regional value. Use 2008 appliance magazine value and scale to region with 4% Also used ARI, No. 7 Exhibit B at p. 1.	Exhibit B at p. 1) • Commercial Refrigeration Equipment to 2014 by Freedonia Group, Inc. (the Freedonia 2010 report)1 • 2008 Size and Shape of Industry by the North American Association of Food Equipment Manufacturers and the updated 2013 report (NAFEM reports)2 • 2012 Size and Shape of Industry by the North American Association of Food Equipment Manufacturers and the updated 2013 report (NAFEM reports)3 • Energy Savings Potential and R&D Opportunities for Commercial Refrigeration prepared by Navigant Consulting, Inc., for DOE (NCI 2009 report).4 • CBECS 1999 and 2003 survey micro-data. • Energy Star Unit Equipment and Market Penetration Reports, 2006-2013. N/A		PC_Packaged_Refrig_ Equipment.xls;
Stock Model						

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Shipment Growth Rate	Shipment growth rate based on forecast	No	6P uses 2012 standard NIA analysis	New equipment is driven by construction of new floor space and replacement units are replaced on a one-for-one basis. Data source : EIA's Annual Energy Outlook (AEO) 2014		DOE TSD Chapter 10 shipment model; CRE_Final_Rule_NIA_ Workbook
Lifetime	Product Lifetime	N/A	The documented lifetime in 6P is 10 years.	TSD: DOE used 15 years as the average equipment lifetime for CRE used in small businesses. Weibull distribution used range of 7-13 years with an average of 10 years For small businesses: Weibull distribution 9-20 years with average of 15 years.		DOE TSD Chapter 10 shipment model; CRE_Final_Rule_NIA_ Workbook

Table C-12. Residential Furnace Fans

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Usage						
2013 Baseline	Baseline device efficiency tiers		N/a	704.8	in kwh/yr.	DOE TSD
2013 Levels	Incremental efficiency tiers in DOE analysis		N/a	330.9-610.2	in kwh/yr. varies by efficiency level	DOE TSD
2013 MH FER	Efficiency Tiers for Manufactured Housing		N/a	174.7-328.7	in kwh/yr. varies by efficiency level	DOE TSD
Heating Hours	Hours spent in heating mode		N/a	495		DOE TSD
Cooling Hours	hours spent in cooling mode		N/a	782		DOE TSD
Annual Electricity Consumption	Electricity Consumption		N/a	553-1110; 312-587	in kwh/yr. varies by efficiency level	DOE TSD
2013 Baseline	Baseline device efficiency tiers			801.6	in kwh/yr.	DOE TSD

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
2013 Levels	Incremental efficiency tiers in DOE analysis			399.3-699.7	in kwh/yr. varies by efficiency level	DOE TSD
2013 MH FER	Efficiency Tiers for Manufactured Housing			222.3-407.7	in kwh/yr. varies by efficiency level	DOE TSD
Heating Hours	Hours spent in heating mode			659		DOE TSD
Cooling Hours	hours spent in cooling mode			495		DOE TSD
Annual Electricity Consumption	Electricity Consumption			553-1110; 397-728	in kwh/yr. varies by efficiency level	DOE TSD
2013 Baseline	Baseline device efficiency tiers		N/A	739.8	in kwh/yr.	DOE TSD
2013 Levels	Incremental efficiency tiers in DOE analysis		N/A	352.3-638.4	in kwh/yr. varies by efficiency level	DOE TSD

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
2013 MH FER	Efficiency Tiers for Manufactured Housing		N/A	0	in kwh/yr. varies by efficiency level	DOE TSD
Heating Hours	Hours spent in heating mode		N/A	432		DOE TSD
Cooling Hours	hours spent in cooling mode		N/A	1026		DOE TSD
Annual Electricity Consumption	Electricity Consumption		N/A	629-1321	in kwh/yr. varies by efficiency level	DOE TSD
2013 Baseline	Baseline device efficiency tiers		N/A	367	in kwh/yr.	DOE TSD
2013 Levels	Incremental efficiency tiers in DOE analysis		N/A	171.8-317.3	in kwh/yr. varies by efficiency level	DOE TSD
2013 MH FER	Efficiency Tiers for Manufactured Housing		N/A	103.6-196.6	in kwh/yr. varies by efficiency level	DOE TSD

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Heating Hours	Hours spent in heating mode		N/A	572		DOE TSD
Cooling Hours	hours spent in cooling mode		N/A	854		DOE TSD
Annual Electricity Consumption	Electricity Consumption		N/A	294-628; 185-351	in kwh/yr. varies by efficiency level	DOE TSD
Market						
Pre-case product class distribution	Number of product class(s) and distribution if standard did not exist		N/a	DOE GRIM Model	GRIM uses NIA shipments.	DOE TSD

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Post-case case product class distribution	Number of product class(s) and distribution factoring in the effective standard		N/a	DOE GRIM Model	GRIM uses NIA shipments.	DOE TSD
Pre-case efficiency level distribution	Efficiency distribution of each product class if standard did not exist		N/a	DOE GRIM Model	GRIM uses NIA shipments.	DOE TSD
Post-case efficiency level distribution	Efficiency distribution of each product class factoring in the effective standard		N/a	DOE GRIM Model	GRIM uses NIA shipments.	DOE TSD
Appliance Saturation	Saturation rate of Furnaces in the NW region		54.1; 5.7; 64.3	N/A	SF/MF/MH; DOE model does not break out by building type	RBSA

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Pre-case product class distribution	Number of product class(s) and distribution if standard did not exist		N/a	DOE GRIM Model	GRIM uses NIA shipments.	DOE TSD
Post-case case product class distribution	Number of product class(s) and distribution factoring in the effective standard		N/a	DOE GRIM Model	GRIM uses NIA shipments.	DOE TSD
Pre-case efficiency level distribution	Efficiency distribution of each product class if standard did not exist		N/a	DOE GRIM Model	GRIM uses NIA shipments.	DOE TSD
Post-case efficiency level distribution	Efficiency distribution of each product class factoring in the effective standard		N/a	DOE GRIM Model	GRIM uses NIA shipments.	DOE TSD

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Appliance Saturation	Saturation rate of Furnaces in the NW region		54.1; 5.7; 64.3	N/A	DOE model does not break out by building type	RBSA
Pre-case product class distribution	Number of product class(s) and distribution if standard did not exist		N/A	DOE GRIM Model	GRIM uses NIA shipments.	DOE TSD
Post-case case product class distribution	Number of product class(s) and distribution factoring in the effective standard		N/A	DOE GRIM Model	GRIM uses NIA shipments.	DOE TSD
Pre-case efficiency level distribution	Efficiency distribution of each product class if standard did not exist		N/A	DOE GRIM Model	GRIM uses NIA shipments.	DOE TSD

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Post-case efficiency level distribution	Efficiency distribution of each product class factoring in the effective standard		N/A	DOE GRIM Model	GRIM uses NIA shipments.	DOE TSD
Appliance Saturation	Saturation rate of Furnaces in the NW region		54.1; 5.7; 64.3		SF/MF/MH; DOE model does not break out by building type	RBSA
Pre-case product class distribution	Number of product class(s) and distribution if standard did not exist		N/A	DOE GRIM Model	GRIM uses NIA shipments.	DOE TSD
Post-case case product class distribution	Number of product class(s) and distribution factoring in the effective standard		N/A	DOE GRIM Model	GRIM uses NIA shipments.	DOE TSD

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Pre-case efficiency level distribution	Efficiency distribution of each product class if standard did not exist		N/A	DOE GRIM Model	GRIM uses NIA shipments.	DOE TSD
Post-case efficiency level distribution	Efficiency distribution of each product class factoring in the effective standard		N/A	DOE GRIM Model	GRIM uses NIA shipments.	DOE TSD
Appliance Saturation	Saturation rate of Furnaces in the NW region		54.1; 5.7; 64.3		SF/MF/MH; DOE model does not break out by building type	RBSA
Stock Model						
Product Lifetime	Furnace fan lifetime		N/A	21.2	No Sixth Plan value	DOE TSD

Table C-13. Electric Motors

Input	Description	Regional Value Different from DOE NIA?	Regional Value	Suggested Value	Notes	Data Source
Usage						
Standard Effective Year	Year when standard comes into effect	N/A	N/A	2016	DOE rulemaking comes into effect in 2016. All NEMA Design A & B electric motors (the only motor types covered in this regional analysis) must meet EL 2, specified in the Code of Federal Regulations, 10 CFR 431.25	10 CFR 431.25
Product Classes	Number and distribution of product classes	Yes	Existing BPA model has 6 product classes: 1-5 HP; 6-20 HP; 21-50HP; 51-100 HP; 101-200 HP; 201-500 HP	6 product classes in total; 1-5 HP; 6-20 HP; 21-50HP; 51-100 HP; 101-200 HP; 201-500 HP	There are 482 different product classes based on motor design, pole configuration, enclosure and horsepower - this analysis simplifies them to six product classes by horsepower ranges. NEMA Design C, fire pump and brake pump motors are not included in this analysis due to extremely low shipment numbers.	DOE Electric Motors Technical Support Document: Table 9.2.2

Input	Description	Regional Value Different from DOE NIA?	Regional Value	Suggested Value	Notes	Data Source
Hours of Operation	Annual operating hours per motor		Existing BPA model: ranges from 2,567 to 5,444	Average operating hours ranges from 1,000 to 7,518 hours per year, based on sector, application and horsepower range		DOE Electric Motors Technical Support Document: Table 7.2.8
Pre-case efficiency level	Efficiency levels prior to standard	N/A	Existing BPA model includes 100% at 2010 standard level in 2010.	Baseline efficiency levels determined by lowest market efficiency products in motor databases for NEMA Designs A & B EL 0: pre-EISA 2007 baseline efficiency level EL 1: based on NEMA MG-1-2011 Table 12-11 EL 2: based on NEMA MG-1-2011 Table 12-12 EL 3 (best-in-market): based on one NEMA level above EL 2 EL 4 (maximum technology): based on one NEMA level above EL 3	Baseline efficiency levels based on analysis of motor database to determine motors with the lowest market efficiency. These baseline efficiencies were targeted to be lower than any existing energy conservation standards (most recently EISA 2007)	DOE Electric Motors Technical Support Document Chapter 5.3

Input	Description	Regional Value Different from DOE NIA?	Regional Value	Suggested Value	Notes	Data Source
Post-case efficiency level	2016 standard, weighted averages to be calculated after combining horsepower classes	N/A	N/A	Standard requires all covered products to meet EL 2 efficiency levels (as specified in the Code of Federal Regulations, 10 CFR 431.25		DOE Electric Motors Technical Support Document: Table 5-4
Market						
Market Distribution by Sector	Electric Motors were shipped to the commercial, industrial, and agricultural sectors	N/A	Existing BPA model: 72% commercial; 28% Industrial	26.1% industrial, 73.8% commercial, 0.1% agricultural for motor classes 1-5 HP; 6-20 HP; and 21-50 HP 63.3% industrial, 29.7% commercial, 7.0% agricultural for motor classes 51-100 HP 76.0% industrial, 20.6% commercial, 3.4% agricultural for motor classes 101-200 HP 69.1% industrial, 27.9% commercial, 3.0% agricultural for motor classes 201-500 HP		DOE Electric Motors Technical Support Document: Table 7.2.6

Input	Description	Regional Value Different from DOE NIA?	Regional Value	Suggested Value	Notes	Data Source
Base case efficiency level distribution	Efficiency distribution of each product class if standard did not exist	N/A	Existing BPA model: 2005-2009: 100% at pre-EISA level; 2010: 100% at EISA	Distribution based on DOE basecase efficiency distribution for 2012 and 2016 - onward; the efficiency distribution accounts for the impact of expansion in scope		DOE Electric Motors: EERE-2010-BT-STD-0027-0112 - NEMA Design A & B Motors
Standard case efficiency level distribution	Efficiency distribution of each product class factoring in the effective standard	N/A	N/A	Distribution based on DOE policy case efficiency distribution for 2016 - onward		DOE Electric Motors: EERE-2010-BT-STD-0027-0112 - NEMA Design A & B Motors

Input	Description	Regional Value Different from DOE NIA?	Regional Value	Suggested Value	Notes	Data Source
Shipment by Product Class	Motor shipments by HP class	N/A	Existing BPA model: Shipment data sourced from NEMA shipment	DOE developed total shipment estimates for 2011 based on IMS market research report and data provided by motor stakeholders such as NEMA, manufacturers and multiple other sources	Shipment data also available at the sector and application level. DOE data was driven by data collected from extensive field measurements by the Washington State University Extension Energy Program (WSU), Applied Proactive Technologies and the New York State Energy Research and Development Authority (NYSERDA) 2 ("WSU/NYSERDA database"), and field data compiled by the Industrial Assessment Center (IAC) at Oregon State University (OSU) ("Northwest Industrial Database")	DOE Electric Motors Technical Support Document: Table 9.2.2

Input	Description	Regional Value Different from DOE NIA?	Regional Value	Suggested Value	Notes	Data Source
Shipment Growth Rate	Sales Growth Estimate	N/A	Existing BPA model: average at 1.4%	Varies - based on Private Fixed Investments Index for applicable equipment and structures	DOE used annual growth rates in private fixed investment for applicable equipment and structures (including motors) as a proxy for annual shipment growth rates, using sources from the U.S. Census Bureau, NEMA and the Bureau for Economic Analysis	DOE Electric Motors: EERE-2010-BT-STD-0027-0109 - Electric Motors Shipment Analysis

Input	Description	Regional Value Different from DOE NIA?	Regional Value	Suggested Value	Notes	Data Source
% Sales Applicable to Standards	Percentage of motor sales affected by the standard	N/A	Existing BPA model: New coverage to NEMA= 25% motors up to 200; 75% for 200-5000 hp. Going to NEMA premium: 65% of all sales except for motors 200hp-500 which were excluded from the standards	Not all motors are subjected to the 2016 standards, such as air-over, liquid-cooled, submersible and inverter-only electric motors. However, the shipment data provided by the DOE is solely for covered electric motors.		DOE Electric Motors Technical Support Document: Table 3.7

Input	Description	Regional Value Different from DOE NIA?	Regional Value	Suggested Value	Notes	Data Source
Stock Model						
Lifetime	Product lifetime	Yes	Existing BPA model: Varies from 17-29 years	Varies by motor classes and sector type; weighted average lifetime range from 8 years to 29 years	Different sectors and applications have different total operating hours, meaning that one motor can have multiple lifetimes across sectors.	DOE Electric Motors Technical Support Document: Table 8.2.22
Product Turnover Assumption	Stock Turnover Rate	Yes	Existing BPA model: 1/lifetime	Weibull distribution	Parameters included within the DOE TSD	DOE Electric Motors Technical Support Document: Table 8.2.25 and Table 8.2.26

Table C-14. Illuminated Exit Signs

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Usage						
Operating hours per year	24/7 operation	N/A	8760 hours/year	N/A	Used in supply curve, found in several resources including DOE 2008 Report	Supply Curve (PC_Exit_Sign_6P_D2.xls); http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/nichefinalreport_october2008.pdf
Number of faces	Number of sides of the exit sign	N/A	2	N/A	Supply curve assumes all signs are double sided.	Supply Curve (PC_Exit_Sign_6P_D2.xls)
5P Baseline Device Efficiency	Fifth Plan baseline device efficiency	N/A	Not included	N/A	N/A	N/A

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
6P Baseline Device Efficiency	Sixth Plan baseline device efficiency	N/A	Incandescent 16 W/face, CFL 8.5 W/face, LED 3 W/face	N/A	Values for 2007	Supply Curve (PC_Exit_Sign_6P_D2.xls); http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/nichefinalreport_october2008.pdf
2006 Standard Device Efficiency	Device efficiency after standard took effect	N/A	5 W/face	N/A	Regional standards never went into effect because of EPACT 2005	DOE (10 CFR 431 Subpart L)
Market						
Pre-case product class distribution	Number of product class(s) and distribution if standard did not exist	N/A	85% LED, 10% CFL, 5% Incandescent in 2010	N/A		Supply Curve (PC_Exit_Sign_6P_D2.xls)
Post-case case product class distribution	Number of product class(s) and distribution factoring in the effective standard	N/A	100% LED	N/A	Use frozen efficiency at EPACT level (5 W/face), which would be 100% LED	Supply Curve (PC_Exit_Sign_6P_D2.xls)

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Pre-case efficiency level distribution	Efficiency distribution of each product class if standard did not exist	N/A	Incandescent 16 W/face, CFL 8.5 W/face, LED 3 W/face	N/A	Values for 2007	Supply Curve (PC_Exit_Sign_6P_D2.xls); http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/nichefinalreport_october2008.pdf
Post-case efficiency level distribution	Efficiency distribution of each product class factoring in the effective standard	N/A	100% LED at 5 W/face	N/A	Use frozen efficiency at EPACT level (5 W/face)	DOE (10 CFR 431 Subpart L)
Appliance Saturation	Saturation rate of exit signs in the NW region	N/A	1.5 million signs in 2010, scaled based on floor space for other years	N/A	Based on 2008 national value scaled to 2010 using 1.6% growth rate from 2008 report. Assumes 4% are in NW (from population?)	Supply Curve (PC_Exit_Sign_6P_D2.xls); http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/nichefinalreport_october2008.pdf

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Stock Model						
Historical Replacement Units Shipment in 2005	Number of exit signs shipped to region in 2005	N/A	Based on historical floor space calculations	N/A	Need to verify with council that the pre-2010 values we selected are correct	Commercial Forecast 6P.xls
New Construction forecast	New construction forecast from 2005-2030	N/A	Based on new floor space and 0.48 signs per 1000sf assumption. See Tab SC-NR cells B15:X18	N/A	Continue to use new floor space assumption, research signs per SF value	Supply Curve (PC_Exit_Sign_6P_D2.xls)

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Product Lifetime	Exit sign Product Lifetime	N/A	13.1 years (LED), 10 years (CFL and incandescent)	N/A	Commercial Master sheet says "Average of lighting system change rate weighted by type" and then calculates turnover rate as 1/13.1; Lifetime in supply curve listed as 13 years in MDataTestLED and MDataEquip tabs (but it is unclear if those tabs are relevant in this analysis)	Supply Curve (PC_Exit_Sign_6P_D2.xls); Commercial Master (Com_Master.xls); PC-ExitSigns-D1(Plan 5).xls
Turnover assumption	Product retirement rate	N/A	1/lifetime	N/A	Commercial Master sheet says "Average of lighting system change rate weighted by type" and then calculates turnover rate as 1/13.1	Commercial Master (Com_Master.xls)
Abandon Rate	Retired units not replaced	N/A	Not included	N/A	Assume it is 0% since exit signs are required for safety	N/A

Table C-15. Commercial Pre-Rinse Spray Valve

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Usage						
Annual Days of Operation	Number of days per year spray valve is used	N/A	365.25 days per year	N/A	RTF file	Regional Technical Forum Workbook (ComCookingPreRinseSprayValve_v2_0 available at http://rtf.nwcouncil.org/measures/
Daily Hours of Use	Number of hours per day spray valve is used	N/A	0.63 hrs./day	N/A	From RTF file; Supply curve assumed 1.29 hours per day for Fifth plan, 0.8 for food service hours pre-case, 1 for food service hours post-case, 0.1 for grocery service hours pre-case, 0.14 for grocery service hours post-case	Regional Technical Forum Workbook (ComCookingPreRinseSprayValve_v2_0 available at http://rtf.nwcouncil.org/measures/

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Change in water Temperature	Change in water temperature from source to fully heated	N/A	36.3F	N/A	From RTF file; 41.8F for food service and 30.3F for grocery service in supply curves	Regional Technical Forum Workbook (ComCookingPreRinseSprayValve_v2_0 available at http://rtf.nwcouncil.org/measures/
Water Heating Efficiency	Efficiency of heating water used in spray valve	N/A	93% for electric	N/A	Water sense report uses 0.90 for electricity and 0.60 for natural gas http://www.epa.gov/WaterSense/docs/prsv_field_study_report_033111v2_508.pdf).	Supply Curve (C_Spray_Head_6P_D1.xls)
5P Baseline Device Efficiency	Fifth Plan baseline device efficiency	N/A	Calculate based on 5500 kWh/head of savings from Fifth plan	N/A		Supply Curve (C_Spray_Head_6P_D1.xls)
6P Baseline Device Efficiency	Sixth Plan baseline device efficiency	N/A	1.6 gpm	N/A		Supply Curve (C_Spray_Head_6P_D1.xls)

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
2006 Standard Device Efficiency	Device efficiency after standard took effect	N/A	Flow rate of not more than 1.6 gpm	N/A		DOE (10 CFR 431 Subpart O)
Market						
Pre-case product class distribution	Number of product class(s) and distribution if standard did not exist	N/A	No product classes	N/A	RTF assumptions include all building types (food service, grocery, etc.)	Regional Technical Forum Workbook (ComCookingPreRinseSprayValve_v1_1) available at http://rtf.nwcouncil.org/measures/
Post-case case product class distribution	Number of product class(s) and distribution factoring in the effective standard	N/A	No product classes	N/A	RTF assumptions include all building types (food service, grocery, etc.)	Regional Technical Forum Workbook (ComCookingPreRinseSprayValve_v1_1) available at http://rtf.nwcouncil.org/measures/

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Pre-case efficiency level distribution	Efficiency distribution of each product class if standard did not exist	N/A	100% at plan device efficiency levels	N/A	Use frozen efficiency at EPACT level from 2006 and later	DOE (10 CFR 431 Subpart O)
Post-case efficiency level distribution	Efficiency distribution of each product class factoring in the effective standard	N/A	Same as pre-case since standards were captured in 5P and 6P	N/A	Use frozen efficiency at EPACT level from 2006 and later	DOE (10 CFR 431 Subpart O)
Appliance Saturation	Saturation rate of spray valves in the NW region	N/A	17,755in 2010, scaled to other years using population growth rate	N/A	EPA Water Sense specifies 1.35 million nationally (http://www.epa.gov/WaterSense/docs/prsv_field_study_report_033111v2_508.pdf)	Supply Curve (C_Spray_Head_6P_D1.xls)
Stock Model						

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Historical Replacement Units Shipment in 2005	Number of spray valves shipped to region in 2005	N/A	Based on population and population growth rate calculations	N/A		Commercial Forecast 6P.xls
New Construction forecast	New construction forecast from 2005-2030	N/A	Based on population growth rate	N/A		Supply Curve (C_Spray_Head_6P_D1.xls)
Product Lifetime	Product Lifetime	N/A	5 years	N/A		Supply Curve (C_Spray_Head_6P_D1.xls); Commercial Master (Com_Master.xls)
Turnover assumption	Product retirement rate	N/A	1/lifetime	N/A		Commercial Master (Com_Master.xls)
Abandon Rate	Retired units not replaced	N/A	Not included	N/A		N/A

Table C-16. Battery Chargers

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Usage						
Pre-case UEC	Average UEC of Non-Compliant Products	No	Same as CEC Value	Varies by Product Class		2011 California Energy Commission Staff Analysis of Battery Chargers and Self-Contained Lighting Controls
Post-case UEC	Average UEC of Compliant Products	No	Same as CEC Value	Varies by Product Class		2011 California Energy Commission Staff Analysis of Battery Chargers and Self-Contained Lighting Controls
Market						
Product Classes	List of Covered Product Classes	No	Same as CEC Value	18 Product Classes Based on Application		2011 California Energy Commission Staff Analysis of Battery Chargers and Self-Contained Lighting Controls
Stock	2009 and 2013 California Stock	Yes	Scaled off CEC value based on Regional Population	Varies by Product Class	Developed from Efficiency Levels and DOE shipments in the Pre-Case	2011 California Energy Commission Staff Analysis of Battery Chargers and Self-Contained Lighting Controls

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
California Population	Population of California in 2009 and 2013	N/A	N/A	2009: 36,961,229 2013: 38,431,393	Used to develop market saturation estimates	US Census
PNW Population	Population of PNW in 2009 and 2013	Yes	1980 to 2010 Populations by County	N/A	Very large dataset	US Census Population Estimates Historical Datasets.
Stock Model						
Product Lifetime	Saturations tab in central residential model	No	N/A	Varies by Product Class		2011 California Energy Commission Staff Analysis of Battery Chargers and Self-Contained Lighting Controls

Table C-17. Walk-in Coolers and Freezers

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Usage						
Standard Effective Year	Year when standard comes into effect	Update	Not in Sixth Plan; 2009 standard modeled in existing BPA WICF model	2017	Modeled 2009 standard in previous BPA model, will update current analysis with 2017 standard	79 FR 32049
Product Classes	WICF have two components- (1) refrigeration system (2) envelope which includes the panel and the display doors.	Possible update	36 combinations of refrigeration system and envelope with shipment analyzed in existing BPA WICF model	22 product classes for refrigeration system and 9 product classes for envelope (components).	DOE's final rulemaking has separate models for refrigeration systems and envelopes.	DOE NIA Walk-in Coolers and Freezers Final Rule Workbook

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Pre-case efficiency	Annual electricity use for each ref/envelope combination according to specifications in the DOE TSD.	N/A	1980-2009: Pre-EISA level;2009-2017: 2009 Standard level	Varies by product class.		DOE NIA Walk-in Coolers and Freezers NIA Workbook; 2015 Standards Rulemaking
Post-case efficiency	The final rule correspond to TSL 2	N/A	N/A	The final rule correspond to TSL 2. See TSL tab for additional information.		DOE NIA Walk-in Coolers and Freezers NIA Workbook; 2015 Standards Rulemaking
Market						
Saturation	Average WICF per million sqft	Update	N/A	27.22 for Systems; 60.43 for Components		Extrapolated to 2010 from 2014 DOE Final Rule TSD Tables 9.6.2 and 9.6.7 using 2014 Annual Energy Outlook 2014: Commercial Sector Key Indicators and Consumption for Floor space

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Pre-case efficiency distribution	Pre-standard efficiency distribution	N/A	2009 WICF standard level in 2017 in existing BPA model	Varies by product class.		Efficiency level sourced from DOE NIA Walk-in Coolers and Freezers Workbook; 2014 Rulemaking. Simplified assumptions for 100% pre-EISA level
Post-case efficiency distribution	Post-standard efficiency distribution	N/A	N/A	Efficiency distribution corresponding to 2017 standard level (TSL 2)		Efficiency level sourced from DOE NIA Walk-in Coolers and Freezers Workbook; 2014 Rulemaking. Simplified assumptions for 100% EISA level

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Compliance Rate for existing stock	For units eligible for replacement in existing buildings, compliance rate might be an issue as facility managers might repair instead of replacing the failed unit	N/A	10 % compliance rate assumed in existing BPA WICF model	N/A	Not used in model.	
Stock Model						
Scalar	Scale national analysis to regional analysis	N/A	4% in existing BPA Analysis	N/A		

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Lifetime	Lifetime is defined as when a refrigeration system or a component fails or needed replacement	Update	Envelope: 15 years, Refrigeration System 12 years, Doors: 14 years	Panels: 12 years; Refrigeration system: 10 years; Display Doors, Small Passage Doors, and Small Freight Doors: 12 years; Large Passage and Freight Doors: 6 years (Assumed 10 years for systems and 12 years for components in model)	Lifetime of WICF averages to be 15 years.	DOE WICF NOPR_TSD Chapter 9

Table C-18. Residential Ovens

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Usage						
1996 Level	Cooking Efficiency		N/A	0.1066		DOE TSD
2009 Levels	Cooking Efficiency		N/A	.1066 - .1209	Incremental efficiency tiers in DOE analysis - efficiency factor	DOE TSD
Cooking Energy	Electrical energy required for cooking		90.7-154.3	70.6-132.4	in kWh/yr. for different efficiency levels	DOE TSD
Self-Cleaning/Ignition Energy	electrical energy required for ignition/cleaning		N/A	0	0 because the standard oven does not have a cleaning cycle	DOE TSD

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Cleaning Cycle per Year	number of cleaning cycles		N/A	0	0 because the standard oven does not have a cleaning cycle	DOE TSD
Clock Energy	electrical energy used by clock per year		N/A	34.2	does not vary by efficiency level	DOE TSD
1996 Level	Cooking Efficiency		N/A	0.1099		DOE TSD
2009 Levels	Cooking Efficiency		N/A	0.1099 - .1123	Incremental efficiency tiers in DOE analysis - efficiency factor	DOE TSD
Cooking Energy	Electrical energy required for cooking		108.0-159.2	116.6; 113.5	in kWh/yr. for different efficiency levels	DOE TSD
Self-Cleaning/Ignition Energy	electrical energy required for ignition/cleaning		N/A	21.1	does not vary by efficiency level	DOE TSD

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Cleaning Cycle per Year	number of cleaning cycles		N/A	4	does not vary by efficiency level	DOE TSD
Clock Energy	electrical energy used by clock per year		N/A	33.3	does not vary by efficiency level	DOE TSD
1996 Level	Cooking Efficiency		N/A	0.0536		DOE TSD
2009 Levels	Cooking Efficiency		N/A	.0583; .06	Incremental efficiency tiers in DOE analysis	DOE TSD
Cooking Energy	Electrical energy required for cooking		N/A	0	no electricity consumed during cooking because this is a gas oven	DOE TSD
Self-Cleaning/Ignition Energy	electrical energy required for ignition/cleaning		N/A	0	0 because the standard oven does not have a cleaning cycle	DOE TSD

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Cleaning Cycle per Year	number of cleaning cycles		N/A	0	0 because the standard oven does not have a cleaning cycle	DOE TSD
Clock Energy	electrical energy used by clock per year		N/A	0	does not vary by efficiency level	DOE TSD
1996 Level	Baseline device efficiency tiers		N/A	0.054		DOE TSD
2009 Levels	Incremental efficiency tiers in DOE analysis		N/A	.054; .0063	Cooking efficiency for different efficiency levels	DOE TSD
Cooking Energy	Electrical energy required for cooking		N/A		in kWh/yr. for different efficiency levels	DOE TSD
Self-Cleaning/Ignition Energy	electrical energy required for ignition/cleaning		N/A	21.8	does not vary by efficiency level	DOE TSD

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Cleaning Cycle per Year	number of cleaning cycles		N/A	4	does not vary by efficiency level	DOE TSD
Clock Energy	electric energy used by clock per year		N/A	31.5	does not vary by efficiency level	DOE TSD
Market						
Pre-case product class distribution	Number of product class(s) and distribution if standard did not exist		N/A	DOE GRIM Model	Took from GRIM (which takes from NIA)	DOE TSD
Post-case case product class distribution	Number of product class(s) and distribution factoring in the effective standard		N/A	DOE GRIM Model	Took from GRIM (which takes from NIA)	DOE TSD
Pre-case efficiency level distribution	Efficiency distribution of each product class if standard did not exist		N/A	DOE GRIM Model	Took from GRIM (which takes from NIA)	DOE TSD

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Post-case efficiency level distribution	Efficiency distribution of each product class factoring in the effective standard		N/A	DOE GRIM Model	Took from GRIM (which takes from NIA)	DOE TSD
Appliance Saturation	Saturation rate of Ovens in the NW region		97.5%; 100%; 96%		DOE model does not break out by different building type	RBSA
Pre-case product class distribution	Number of product class(s) and distribution if standard did not exist		N/A	DOE GRIM Model	Took from GRIM (which takes from NIA)	DOE TSD
Post-case case product class distribution	Number of product class(s) and distribution factoring in the effective standard		N/A	DOE GRIM Model	Took from GRIM (which takes from NIA)	DOE TSD
Pre-case efficiency level distribution	Efficiency distribution of each product class if standard did not exist		N/A	DOE GRIM Model	Took from GRIM (which takes from NIA)	***DOE TSD***

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Post-case efficiency level distribution	Efficiency distribution of each product class factoring in the effective standard		N/A	DOE GRIM Model	Took from GRIM (which takes from NIA)	DOE TSD
Appliance Saturation	Saturation rate of Ovens in the NW region		97.5%; 100%; 96%		DOE model does not break out by different building type	RBSA
Pre-case product class distribution	Number of product class(s) and distribution if standard did not exist		N/A	DOE GRIM Model	Took from GRIM (which takes from NIA)	DOE TSD
Post-case case product class distribution	Number of product class(s) and distribution factoring in the effective standard		N/A	DOE GRIM Model	Took from GRIM (which takes from NIA)	DOE TSD
Pre-case efficiency level distribution	Efficiency distribution of each product class if standard did not exist		N/A	DOE GRIM Model	Took from GRIM (which takes from NIA)	DOE TSD

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Post-case efficiency level distribution	Efficiency distribution of each product class factoring in the effective standard		N/A	DOE GRIM Model	Took from GRIM (which takes from NIA)	DOE TSD
Appliance Saturation	Saturation rate of Ovens in the NW region		97.5%; 100%; 96%			RBSA
Pre-case product class distribution	Number of product class(s) and distribution if standard did not exist		N/A	DOE GRIM Model		DOE TSD
Post-case case product class distribution	Number of product class(s) and distribution factoring in the effective standard		N/A	DOE GRIM Model		DOE TSD
Pre-case efficiency level distribution	Efficiency distribution of each product class if standard did not exist		N/A	DOE GRIM Model		DOE TSD

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Post-case efficiency level distribution	Efficiency distribution of each product class factoring in the effective standard		N/A	DOE GRIM Model		DOE TSD
Appliance Saturation	Saturation rate of Ovens in the NW region		97.5%; 100%; 96%			RBSA
Stock Model						
Product Lifetime	Residential Ovens Spreadsheet Cooking Eff Tab	Yes, different from DOE	20 years	19 years		DOE TSD, Sixth Plan
Product Lifetime	Residential Ovens Spreadsheet Cooking Eff Tab	Yes, different from DOE	20 years	19 years		Product Lifetime
Product Lifetime	Residential Ovens Spreadsheet Cooking Eff Tab	Yes, different from DOE	20 years	19 years		DOE TSD, Sixth Plan

Input	Description	Regional Value Different from DOE NIA?	Regional Value	DOE Value	Notes	Data Source
Product Lifetime	Residential Ovens Spreadsheet Cooking Eff Tab	Yes, different from DOE	20 years	19 years		DOE TSD, Sixth Plan