Methodologies for Calculating Momentum Savings

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Table of Contents

List of Figures

List of Tables

Acknowledgements

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The team would like to thank Carrie Cobb at Bonneville Power Administration (BPA) for her commitment to communicating in a way that enables our audience to access these complicated concepts. She puts the "people" back in our business and reminds us frequently that we need to meet people where they are.

We would also like to thank Bonnie Watson, Michele Francisco, and Kevin Geraghty at BPA, whose collective persistence and insight helped the team solicit input from a broader group and refine the messaging in this report. Their individual strengths integrated to make a formidable team.

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That said, any errors or omissions are the responsibility of the research team.

Foreword

The methodologies contained with this document are the result of many months of ongoing development, review, and iteration. Momentum Savings research is in its infancy, and will greatly improve the region's understanding of energy efficiency as a resource.

The methods to track Momentum Savings and assess the current practice baseline will evolve as the research team and stakeholders seek to enhance each method. As such, this document is a living document, which will be revised and updated over time as our understanding and knowledge of market analysis evolves and matures.

Within the current document, we have included methods for projects we have not yet attempted, such as residential building envelope and consumer electronics. These methods are likely to greatly improve once we have attempted data collection and analysis. We may also find that some markets are so variable and data intensive that the benefits of greater understanding are not enough to justify the expense and difficulty of quantifying those markets.

In the meantime, we are taking steps to recognize the different stages of evolution of the methodologies. For example, BPA has held off on finalizing savings for the non-residential lighting and residential HVAC markets until the research team can collect additional data. Some of the key inputs in in these markets are based on professional judgment or lack sufficient transparency. We are keeping these estimates in draft because adjustments to these key inputs could change the savings estimate at the population level.

Moving into the future, we plan to continuously improve the Momentum Savings research. Over the next five years, we hope to include the following improvements to the Momentum Savings research:

1. Implementing a robust external review process on all savings models;
2. Sharing our findings for load forecasting as we gain experience quantifying markets over longer periods of time;
3. Improving sensitivity analysis in the models to identify the key drivers and improve the data underpinning the key drivers;
4. Incorporating uncertainty parameters into the analysis; and
5. Quantifying the capacity as well as energy benefits of market changes.

This document is focused on market-level analysis, but Momentum Savings research also includes a significant body of research quantifying the impacts from federal standards. The reports and models for those analyses are located at the BPA webpage at www.bpa.gov/goto/MomentumSavings.

Carrie Cobb
BPA Market Research Lead
December 2015

Glossary

actual consumption, actual energy use	The amount of energy the market actually consumed in each year of the analysis period.
actual efficiency mix	The actual distribution of sales within each efficiency level in a given market during each year of the analysis period.
adjusted baseline	The best possible estimate of the average unit energy consumption or actual efficiency mix in the baseline year; the result of a baseline adjustment.
analysis period	The year(s) covered by a given Momentum Savings analysis scope. The analysis period is a subset of the years covered by a given Power Plan.
annual market size	A metric representing the number of units sold within a given market in each year of the analysis period; the metric may be a direct measure or a proxy for the number of units sold, such as affected square footage.
average unit energy consumption	The energy consumed by the average unit sold in the market, taking into account the efficiency mix (i.e., the varying percentages of units sold at each efficiency level).
baseline adjustment	The process of revising the Northwest Power and Conservation Council (the Council) baseline to reflect the best possible estimate of baseline efficiency mix in the baseline year; occurs if better data on the baseline year's efficiency mix becomes available after the Power Plan is finalized.
baseline consumption, baseline energy use	The amount of energy the market would consume in each year of the analysis period if the baseline efficiency mix from the Council baseline or adjusted baseline remains constant over the analysis period.
baseline efficiency mix	The distribution of total sales within each efficiency level in a given market as assumed in the Council baseline or adjusted baseline.
baseline year	The year in which the baseline is frozen for the purposes of estimating total market savings; typically the year before the Power Plan period begins (e.g., 2009 for the Sixth Plan).
bottom-up analysis	A method in which the analyst scales up sales data covering some portion of the market to estimate sales in the entire market.
busbar factor	A factor applied to account for transmission losses so that savings reflect generation avoided.
Chain Logic Method	A method of extrapolating sales data to estimate the efficiency mix of the entire market.

channel	The path through which products travel from the manufacturer to the end-user (e.g., directly from the manufacturer or through other market actors such as retailers or distributors).
Council baseline	The average unit energy consumption or efficiency mix of new products sold, as assumed in the Council's Power Plan; frozen for the duration of the Plan period or updated based on the implementation of a more efficient code/standard; intended to reflect the current practice baseline in the baseline year based on the data available at the time the Power Plan was prepared.
current practice baseline	A baseline defined by the recent typical choices of end-users in purchasing new equipment.
early retirement	Units installed to replace still-functioning units.
efficiency levels	The categories of product types and efficiencies within a given market, ranging from the least efficient (e.g., code minimum) to most efficient available.
efficiency mix	The distribution (i.e., percentage) of sales within each efficiency level in a given market in a given year.
lighting power density	A measure of the output from lighting in watts per square foot.
lumen	A measure of the total amount of visible light emitted by a source.
market	The sectors, product types, applications, and geographies included within the scope of a given Momentum Savings analysis. A market may include multiple interchangeable product types or technologies that fulfill the same end-use (e.g., CFLs and LEDs).
Momentum Savings	Cost-effective energy savings resulting from newly installed energy efficiency measures, which are above the Council baseline and not included in program savings.
Momentum Savings Analysis Framework	A conceptual framework used across all markets to explain the methodologies for estimating Momentum Savings.
natural replacement	A scenario in which new lighting equipment is required due to system replacements and upgrades.
net market effects	Energy savings claimed by the Northwest Energy Efficiency Alliance (NEEA); a subset of program savings.
product flow	New units purchased in a given year; represents the current purchasing decisions of the market.
Installed stock	Existing installed units; represents historical choices of the market.

program savings	Energy savings paid for and directly claimed by BPA programs, utility programs, and NEEA programs.
replace-on-burnout	Units installed to replace units that have reached the end of their useful life.
saturation	The percentage of homes or buildings within a market in which a certain product category (e.g., clothes washers) is currently installed.
Seventh Power Plan (Seventh Plan)	The document in which the Council will define its baselines for the 2016–2021 planning period; in the process of being finalized as this report was written.
Sixth Power Plan (Sixth Plan)	The document in which the Council defined its baselines for the 2010–2015 planning period; formally known as the Sixth Northwest Conservation and Electric Power Plan.
stock turnover model	A method of estimating the annual market size using assumptions from the Council or other sources about how frequently equipment needs replacing.
top-down analysis	A method in which the analyst scales down sales data from a broader market level to estimate sales within the market in the Momentum Savings analysis scope.
total market savings	The difference between actual consumption and baseline consumption within a given market; includes program savings and Momentum Savings.
turnover rate	The percentage of existing units that will be replaced in any given year.
transmission loss	The decrease in the amount of energy from the point of generating project interconnection to the point of wholesale delivery
unit energy consumption (UEC)	The energy consumed by a unit at a given efficiency level.

List of Acronyms and Abbreviations

AAMA	American Architectural Manufacturers Association
AHRI	Air Conditioning, Heating & Refrigeration Institute
aMW	Average megawatts
ASHP	Air source heat pump
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
BPA	Bonneville Power Administration
CBSA	Commercial Building Stock Assessment
CEA	Consumer Electronics Association
CFL	Compact fluorescent light
Council	Northwest Power and Conservation Council (also referred to as NWPCC)
CPA	Conservation Potential Assessment
DOE	U.S. Department of Energy
DVR	Digital video recording
EIA	U.S. Energy Information Administration
EISA	Energy Independence and Security Act of 2007
EPA	U.S. Environmental Protection Agency
EPS	External power supply
ETO	Energy Trust of Oregon
HD	High definition
HID	High-intensity discharge lighting
HSPF	Heating Seasonal Performance Factor
HVAC	Heating, ventilation, and air conditioning
IAD	Integrated access device
kWh	Kilowatt-hour
LED	Light-emitting diode
LPD	Lighting power density
MW	Megawatt
NEEA	Northwest Energy Efficiency Alliance
PC	Personal computer
RBSA	Residential Building Stock Assessment
RTF	Regional Technical Forum

SEEM	Simplified Energy Enthalpy Model
SNE	Small network equipment
STB	Set-top box
UEC	Unit energy consumption
WDMA	Window and Door Manufacturers Association

Introduction

Power is a resource worth planning for.

In 1980, Congress embodied this sentiment in the Pacific Northwest Electric Power Planning and Conservation Act. This law directed Idaho, Montana, Oregon, and Washington to form the Northwest Power and Conservation Council (the Council). The names of the law and of the Council are illustrative: both place equal weight on generation and conservation.

Power is a resource. So, too, is the conservation of power.

The Council recognizes conservation as a resource. It plans for conservation in the same way as power generation resources by taking into account all associated costs and benefits. Congress charged the Council with balancing these costs and benefits "while also ensuring that the Pacific Northwest has an adequate, efficient, economical, and reliable electric power supply."[1]

"In fact, the Act designates efficiency improvements as the highest-priority resource for meeting electricity demands."

Sixth Northwest Conservation and Electric Power Plan

To this end, the Council prepares a regional power supply plan approximately every five years. This plan includes a comprehensive assessment of the power supply and conservation potential needed to meet the forecasted future regional resource needs. The power supply forecast estimates the cost of potential future generation, while the conservation supply curves estimate the cost of achievable energy efficiency available to reduce future demand.[2] The Council compares the costs of achievable energy efficiency with the costs of future generation to estimate the cost-effective conservation potential. By definition, this cost-effective efficiency resource is a better value for the Northwest than new power generation.

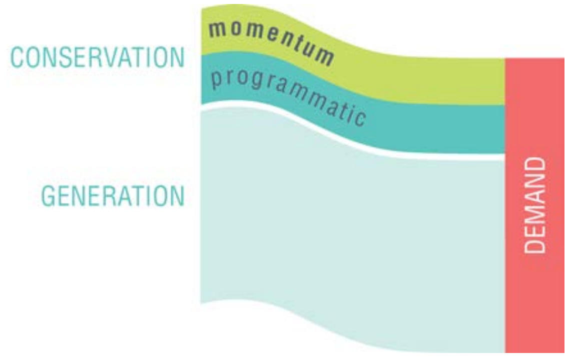
The Council is indifferent to how the region achieves conservation. Two types of savings comprise the conservation resource:

- **Programmatic energy savings**, resources directly paid for by utility programs or part of the net market effects of the Northwest Energy Efficiency Alliance (NEEA), are the most familiar component of the region's resource acquisition strategy.
- **Momentum Savings** represent all other energy savings, whether the indirect legacy of past programs or those that occur independent of utility incentives. For example, savings from ***new codes and standards*** result from new state building codes or federal appliance standards implemented during the Council's planning period and are not accounted for in the Council baseline.

[1] *The Pacific Northwest Electric Power Planning and Conservation Act*. 16 United States Code Chapter 12H (1994 & Supp. I 1995). Act of Dec. 5, 1980, 94 Stat. 2697. Public Law No. 96-501, S. 885.

[2] The Council has used program results as an input into the estimation of achievable energy efficiency available in the next plan period. The Council did not explicitly account for Momentum Savings in the development of the Seventh Plan's conservation supply curves, but the Council has not yet determined its approach to counting Momentum Savings in the Eighth Plan. In the meantime, BPA provides data from Momentum Savings analyses to the Council and other parties on request.

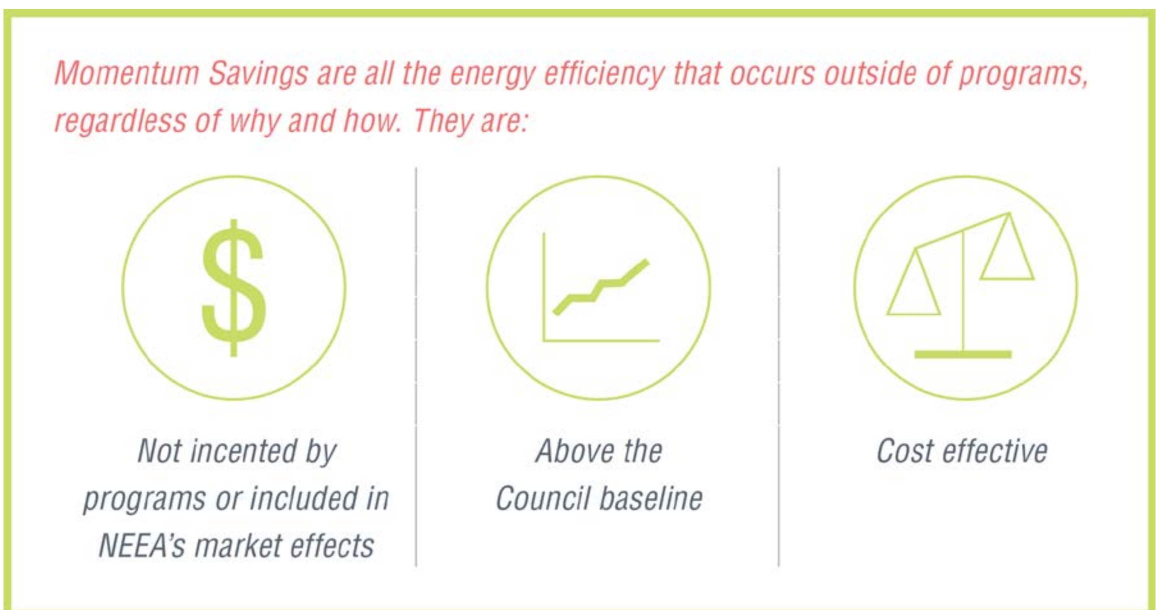
Figure 1: Resources to Meet the Forecasted Demand of the Northwest



Source: Research team analysis, 2015.

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 programs directly incent efficiency improvements.[3]

Evaluators, researchers, and policymakers debate and analyze the size of the conservation resource on a daily basis. The intention is understandable: "You get what you measure," as the saying goes. Whether delivered by programmatic interventions or by momentum in the market, conservation is generation not needed.



[3] Estimating savings that occur outside of programs is not a new concept, as evidenced by market effects studies conducted across the country. See, for example, the recent LED market effects study completed in Massachusetts (DNV-GL, 2015). http://ma-eeac.org/wordpress/wp-content/uploads/LED-Market-Effects-Baseline-Characterization-Final-Draft.pdf. Momentum Savings studies differ from market effects studies in that the Momentum Savings analytical focus is on the change in average UEC of all products within a given market over time compared with a frozen baseline.

A Starting Point for Measurement: Baselines

Conservation is as real as a power plant, but it cannot be physically measured in the same way as the power generated by a power plant. In fact, the region can only measure the conservation resource using agreed-upon assumptions about the decisions that energy consumers might make under different market conditions. Those decisions might involve purchasing a product that consumes less energy or changing specific behaviors that affect energy use. Planners make these assumptions using market research, their knowledge about the market, and a bit of guesswork.

The energy planning world calls this type of assumption a ***baseline***. Baseline assumptions allow Momentum Savings analysts to create a snapshot of the market based on all data available at a given point in time. Real-world actions or product purchases generate savings when they result in a more efficient use of energy than assumed in the baseline.

Approximately every five years, the Council establishes baseline assumptions for a suite of end-uses. These Plan baselines represent more than just something from which the Council derives targets. In a very real way, the Plan baselines reflect both the past successes and future challenges of the Northwest conservation community. Embedded in the baselines is a certain level of resource acquired through previous programmatic interventions or historical market momentum, including:

- The past efforts of utility rebate programs to change consumer behavior
- The successful transformation of the market through a regional effort
- A U.S. Department of Energy (DOE) federal standard that secured the remainder of the market

The baselines serve as a starting point for the challenge put to the region in the form of conservation targets for each planning period. The baselines are the threshold for calculating how many power plants might be avoided and how much potential conservation exists in the region. Everyone plays a role in the conservation resource, and everyone benefits from it.

The Council freezes the baselines specified in the Power Plan for the planning period.[4] This frozen baseline provides clarity to the utilities acquiring the conservation resource. Instead of a moving target, utilities use this baseline as a starting point from which to develop plans to successfully achieve their targets.

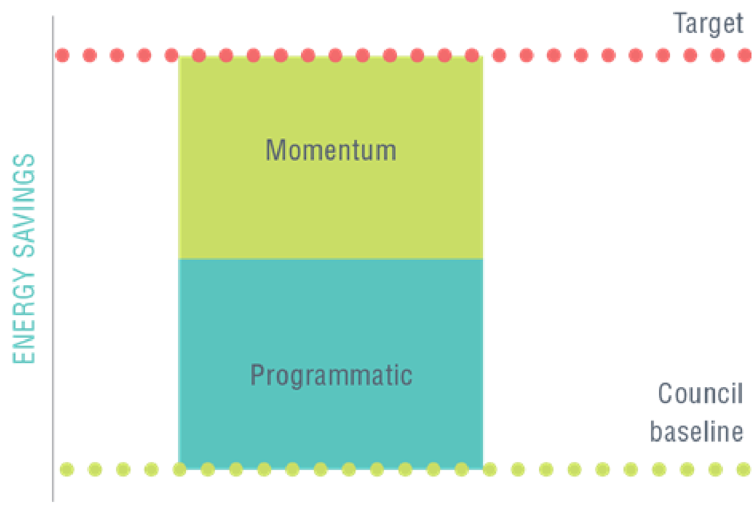
Measuring each utility's progress toward its conservation target gives credibility to the conservation resource. The region counts on this resource to avoid building a new power plant and thus needs reliable measurements of the magnitude of the resource. The methods for measurement, however, are not always straightforward.

The Council and BPA measure and quantify both programmatic and Momentum Savings against the frozen baselines. A rich body of work documents the approaches to, limitations of, and results from quantifying programmatic savings. Evaluators have sought to refine these approaches and results for more than 30 years, and they continue to seek to advance the methodologies. Momentum Savings,

[4] The one exception to the frozen baseline is when the Council knows that a new code or standard will take effect midway through the planning period. If the new code or standard is more efficient than the frozen baseline set at the start of the planning period, the Council modifies the baseline to meet the new code or standard in the year it goes into effect. The Council then re-freezes the baseline at the code/standard level for the remainder of the planning period.

however, require a fundamentally different quantification approach simply because there is no programmatic record of them.

Figure 2: Measuring Progress Toward Council Conservation Targets



Source: Research team analysis, 2015

A previous Bonneville Power Authority (BPA) report first addressed the challenge of quantifying Momentum Savings.[5] Since the report's publication in 2011, BPA has conducted several market studies that have shed additional light on the scope and scale of Momentum Savings. In a short time, BPA's view of Momentum Savings has shifted from an ancillary phenomenon—on the periphery of programmatic activity—to a key component of regional energy efficiency.

As a result, BPA's approach to thinking about the quantification of Momentum Savings, which started with a widget-based, measure-by-measure perspective, has evolved to a much broader view encompassing the actions and motivations of market actors and end-users within each energy efficiency market. This shift in perspective drove a need to build on the concepts that the 2011 report laid out.

[5] Bonneville Power Administration. *Methodology for Quantifying Market-Induced, Non-Programmatic Savings*. Prepared by The Cadmus Group, Inc. April 1, 2011. http://www.bpa.gov/EE/Utility/research-archive/Documents/Market_Induced_Savings_Report.pdf.

Momentum Savings Build On and Enhance Programmatic Savings

Viewing Momentum Savings through a market-wide lens allows the region to capitalize on the investments made in efficiency and target future investments more effectively. The region's historic and current energy efficiency programs support and maintain Momentum Savings.

The program investments of the past are deeply embedded in the infrastructure of delivering efficiency. The region's programs help drive economies of scale in efficient products, train the workforce to install newer technologies, and change the way the culture values energy efficiency. The fact that Momentum Savings exist in the Northwest demonstrates that the region's programs matter.

The region invests millions of dollars each year to drive toward a more energy-efficient future. Momentum Savings will help secure more efficiency for that financial investment. Not all measures and markets require an incentive for every efficient measure delivered in the region, due to the successes of past investments and other market forces. In some markets, the region's work has created momentum; programs can now do less and still move the market and capture the savings. Program managers can invest their time and funds into markets or technologies that need more intervention to advance the market for efficiency. In these markets, market research will help program staff design and execute more effective interventions.

Momentum Savings research staff need program staff partners. Without the programmatic relationships with market actors and the insights that come from program managers, the market research would not be successful.

Market actors participate in research and provide data due to the strong programmatic relationships and investments the region has made. The region's programs not only drive energy efficiency investments inside and outside of programs but also facilitate the access to data and information necessary to conduct Momentum Savings research. Program impact evaluations provide rich, region-specific data on the energy consumption and operating characteristics of measures, which are essential inputs into the quantification of Momentum Savings.

The mass of the region's program investments drives the momentum in the market.

KEEPING THE MO•MEN•TUM

Energy efficiency in the region is gaining traction. The region's programs are critical to the market savings and to maintaining the momentum. Programs and momentum savings research efforts have a beneficial symbiotic relationship.

Organization of the Report

This report advances the region toward its goal of having robust and transparent methods for quantifying Momentum Savings in the Northwest. The report is organized as described here.

The next three chapters present cross-cutting approaches that analysts will use to calculate Momentum Savings in most markets. Utilizing these approaches consistently across markets provides a common and consistent language for communicating the Momentum Savings analyses. BPA hopes this common framework will facilitate more effective stakeholder review of its analyses, leading to more robust and transparent results. The three cross-cutting approach chapters include the following:

- **The Momentum Savings Analysis Framework:** A conceptual framework of four questions used across all markets to explain the methodologies for estimating Momentum Savings
- **Chain Logic Method for Working with Sales Data:** The Chain Logic Method, the approach to employing sales data to improve estimates of baseline and Momentum Savings

The research team improves these methods and develops new methods on an ongoing basis. The research team will issue updates to this report as they become available.

The Momentum Savings Analysis Framework

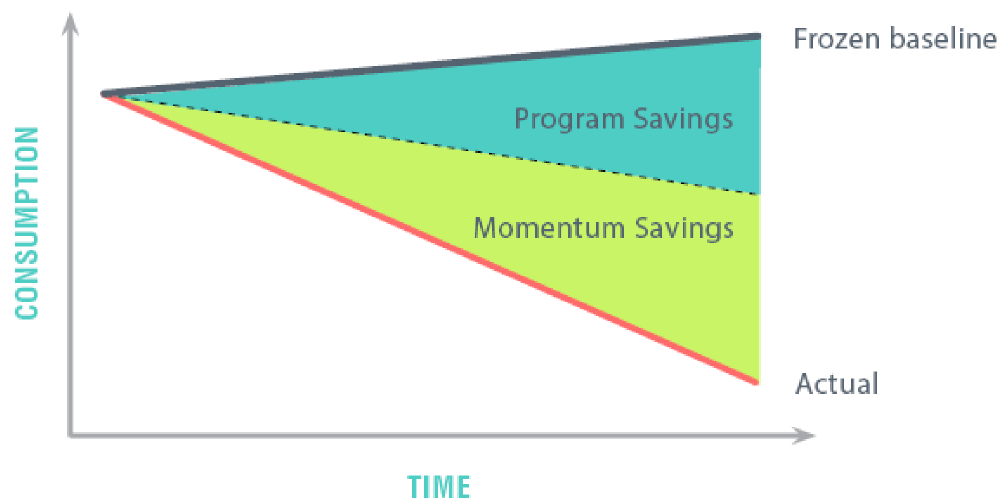
This chapter describes the analytical framework BPA uses to estimate market-wide Momentum Savings.

At the highest level, the calculation of Momentum Savings in a given market follows this equation:

*Total **Market** Savings - Total **Program** Savings = **Momentum** Savings*

The analyst measures each of these terms against a consistent baseline tied to the Council's Power Plan as shown in Figure 3.

Figure 3. Relationship between Total Market Savings and Momentum Savings



Note: the frozen baseline may increase over time if a market is growing in size.

The framework requires the analyst to answer the following four core questions to quantify Momentum Savings for any market:

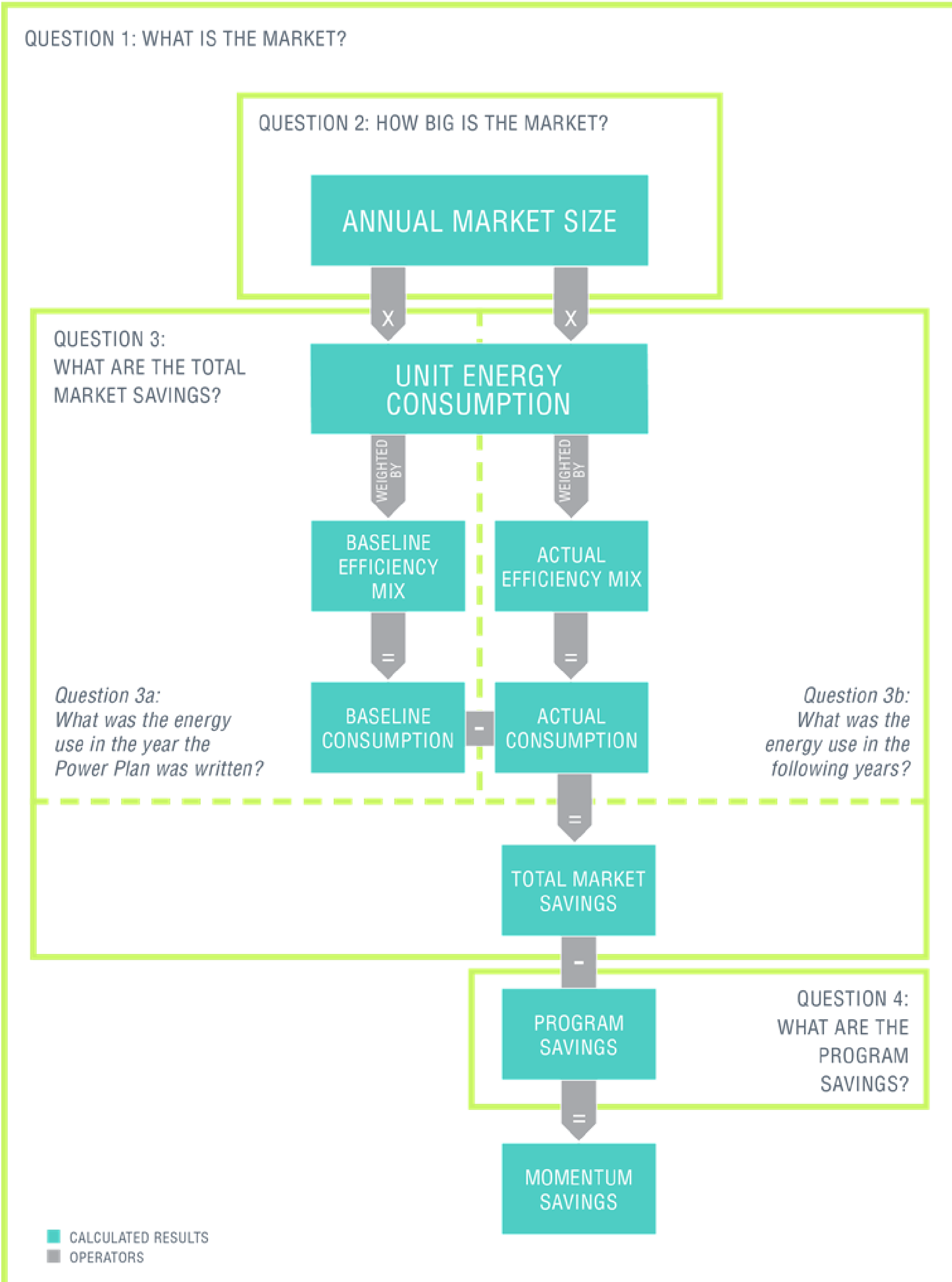
1. What is the market?
2. How big is the market?
3. What are the total market savings?
4. What are the program savings?

These questions provide the analyst with all of the data necessary to estimate Momentum Savings—the cost-effective savings[6] that occur above the frozen baseline and that are not directly incented by

[6] Momentum Savings analysis leverages the cost-effectiveness research conducted throughout the region (e.g., by the Council and the Regional Technical Forum) rather than conducting new research. At this time, we are using the RTF costs and lifetimes as sufficienctly rigorous.

programs or claimed as part of NEEA's net market effects. Figure 4 summarizes how the questions fit together to enable the estimation of Momentum Savings.

Figure 4. Overview of the Momentum Savings Analysis Framework



Source: Research team analysis

To calculate Momentum Savings, the analyst's perspective must include all activity in a given market, not just programmatic. Therefore, the natural starting point for the analysis is to define the market.

Question 1: What is the market?

The definition of the market establishes the boundaries of the analysis. It requires the analyst to consider the market along many dimensions:

- Which sectors does the market include?
- Which housing types or building types does the market include?
- Which product types or measures does the market include?
- Does the market include applications in new construction, early retirement, and replace-on-burnout, or just some subset of those scenarios?
- What geographic territory does the analysis cover?
- How could reviewers misinterpret the terms of the chosen market definition? For example, does residential lighting include multi-family homes and common areas? Does the HVAC market include tune-ups and duct sealing or just the equipment?

Definitional clarity leads to analytical clarity. The analyst will explicitly state which sectors, product types, applications, and geographies the analysis will include, as well as the rationale for any exclusions, if applicable. These foundational decisions will make the analysis easier to communicate and understand.

Question 2: How big is the market?

The total number of units sold in a given calendar year – the product flow – defines the size of the market from Question 1.

The total number of units includes units of all efficiency levels. This market is separate from existing installations—or stock—that resulted from decisions made in the past. This distinction is most critical in rapidly changing markets where new technologies offer the potential for change. In such cases, product flow can look very different from the product stock in the field. In the parlance of the Northwest efficiency community:

- Product flow into the market represents the current practice baseline, the choices consumers make today (e.g., new lightbulbs being sold into the market this year).
- Product stock, on the other hand, represents historical choices and, therefore, may not reveal current trends in the market (e.g., lightbulbs already installed in homes and businesses in past years).

The analyst may leverage several analytical methods to calculate market size. The optimal method is the one that produces the estimate with the least uncertainty. Ideally, the analyst could collect sales data from all sellers in the market and simply add up the total units sold. In reality, such a complete data set is rarely available. The analyst may use several common methods for estimating market size given incomplete data, including:

1. **Stock turnover approach.** This method begins with the estimated installed stock for the market of interest (e.g., the number of air source heat pumps (ASHPs) installed in homes in the Northwest). NEEA's commercial[7] and residential[8] building stock assessments produce this kind of data for the Northwest. The analyst assumes that, on average, the replacement market in any given year is equal to the total existing stock divided by the typical lifetime of the technology (in years). New shipments must replace these failed units. Next, the analyst estimates the shipments for new construction applications by multiplying an assumed saturation rate of the relevant product(s) in new homes by the number of new homes built each year. The sum of the shipments for new construction applications and the shipments replacing failed units are a reasonable representation of the total annual market size.

2. **Bottom-up analysis**. In this method, the analyst extrapolates, or scales up, sales data covering some portion of the market to estimate total market sales. This extrapolation can take on many forms. The most basic approach is to extrapolate sales data based on the data provider's estimated market share. For example, if a retailer with a 10% regional market share reports sales of 100 lamps in 2014, the analyst estimates a total market size of 1,000 lamps. The analyst can provide several market size estimates when the analyst has sales data from several market actor groups (e.g., retailers and distributors). These estimates could either be averaged to arrive at one market size estimate or the analyst may, depending on the data quality from each market actor group, judge one of the estimates as more credible than the others. Using this simple method in concert with other approaches helps alleviate the effects of the varying reliability of market share estimates.

3. **Top-down analysis.** A typical top-down analysis starts at a broader market level and scales down to the market of interest to the analysis. For example, the analyst might scale the size of the national lighting market to the regional level based on the ratio of regional residential square footage to national residential square footage.

The most appropriate approach for a given analysis will depend on the quantity and quality of the data available to the analyst. When possible, analysts should develop market size estimates using multiple approaches to ensure robust estimates.

Question 3: What are the total market savings?

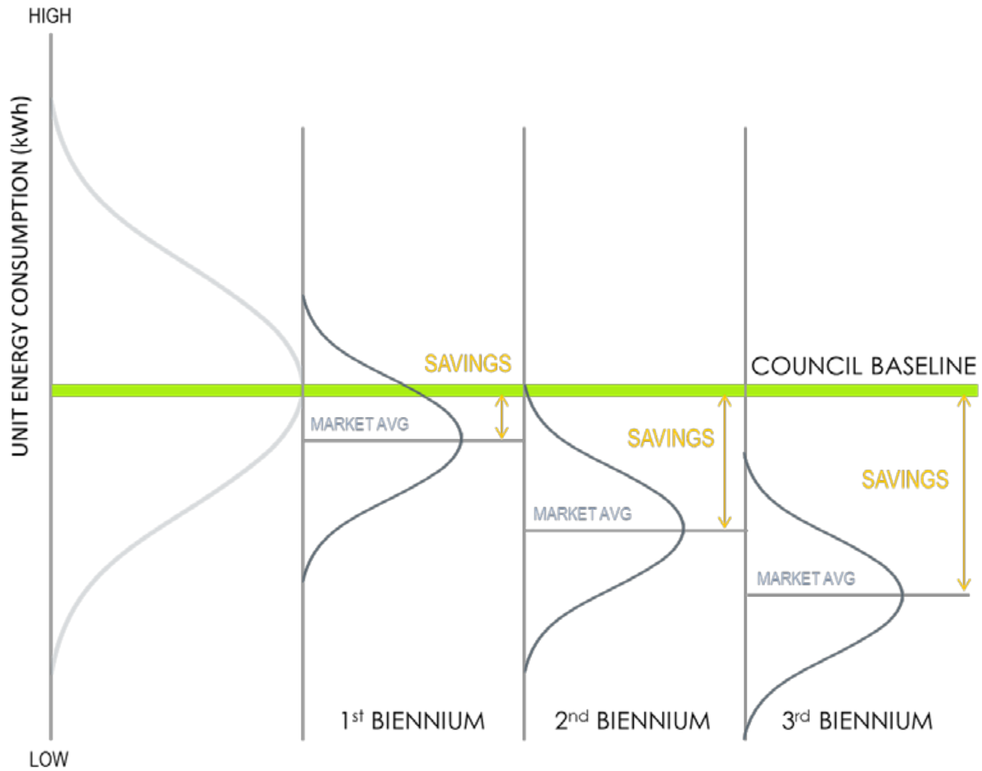
Total market savings are the difference between baseline energy consumption and actual energy consumption.

A market's energy consumption is equal to the energy consumed by an average unit in one year (i.e., the average UEC weighted by the efficiency mix) multiplied by the number of units sold each year). If the actual average UEC is lower than the baseline UEC (due to a difference in the efficiency mix), then there are savings in the market relative to the baseline assumptions. The estimation of total market savings requires a measure of the annual market size (as estimated in Question 2) in addition to the difference between the average unit energy consumption (UEC) of new units sold in the baseline year (Question 3a)

[7] Northwest Energy Efficiency Alliance. "Commercial Building Stock Assessment." http://neea.org/resource-center/regional-data-resources/commercial-building-stock-assessment (accessed July 31, 2015).
[8] Northwest Energy Efficiency Alliance. "Residential Building Stock Assessment." http://neea.org/resource-center/regional-data-resources/residential-building-stock-assessment (accessed July 31, 2015).

and in each subsequent year of the analysis period (Question 3b). Figure 5 demonstrates how energy savings materialize when the average UEC in a market decreases over time, relative to the baseline.

Figure 5. Measuring Against the Frozen Baseline



Source: Research team analysis

The analysis uses an estimate of annual market size, which includes program-incented and non-programmatic units.[9] Therefore, the difference between the baseline consumption and actual energy consumption are the total market savings, inclusive of program and Momentum Savings.

Question 3a: What was the energy use in the year the Power Plan was written?

The Council makes assumptions in every Power Plan about how much energy each analyzed market will consume each year of the planning period.

Energy use includes energy consumed by every unit sold in the market, whether efficient or inefficient. This is the baseline against which the Council sets energy savings targets and against which analysts typically measure total market savings; any lower level of consumption represents energy savings.

Typically, the Council establishes a baseline that represents the estimated average annual energy use for units sold in the year before the Plan begins (i.e., the baseline year).

[9] Note that both the baseline and actual scenarios use the same annual market size estimate; however, in certain markets, a percentage of sales in the actual scenario would not have occurred in the baseline scenario. The analyses treat those customers who would have done nothing (e.g., installed no insulation) as a separate tier in the efficiency mix with their own UEC rather than using a different annual market size. See, for example, the Residential Building Envelope Momentum Savings Calculation Methodology chapter.

For example, the Sixth Power Plan (Sixth Plan) baseline used 2009 as a reference; the Sixth Plan period began on January 1, 2010. The Council baseline is then frozen, meaning that the Council compares energy consumption during the Plan period to the amount of energy consumed by those units sold in the baseline year.[10]

In some cases, more complete data on the average energy use of units sold in the baseline year becomes available after the Council finalizes the Power Plan. The intent of the Council baseline is to accurately reflect the actual efficiency mix of sales in the baseline year, which they must estimate during the baseline year as sales are still occurring. In some cases, analysts and researchers may gain access to relevant market data on the baseline year's actual efficiency mix after the Council has set its baseline.

In these cases, the Momentum Savings analyst may make a baseline adjustment to true up the baseline to actual market conditions. This enables the analysis to capture the spirit of the Council baseline, which represent the actual average UEC in the baseline year. The analyst then measures total market savings (and thus Momentum Savings) against the new adjusted baseline rather than the Council baseline. The analyst makes such a baseline adjustment only in specific scenarios (discussed in more detail in the Baseline Adjustment chapter).

The analyst estimates the number of units sold each year (i.e., the annual market size) in Question 2; the analyst assumes the annual market size is the same in both the baseline and actual scenarios. Savings result from the difference between the average UEC in the baseline scenario and each year of the analysis period.

Arriving at that average UEC requires considering the energy use for units at each efficiency level in addition to the efficiency mix:

1. **Annual energy use for each efficiency level.** A unit's annual energy consumption depends on several factors, including the type of product and its size, efficiency, duty cycle, and operating conditions. The Council conducts engineering analyses and makes assumptions about these parameters based on the best data available at the time of the Plan's writing. This is similar to the way that programs make assumptions about savings for deemed measures with pre-approved per-unit energy savings estimates. Momentum Savings analysts use the results of the Council's analyses, program impact evaluations, and other regional and national research to estimate the annual UEC for each efficiency level.
2. **Baseline efficiency mix.** The efficiency mix represents the share of total sales within each efficiency level. A simple illustration of the concept is a market with two efficiency levels—the minimum allowable efficiency per code (code minimum) and an ENERGY STAR level. The Council Plan might assume an efficiency mix of 70% code minimum and 30% ENERGY STAR. Typically, products have several possible efficiency levels, but the concept is no different.

[10] Note the one exception to the frozen baseline is when new codes or standards go into effect midway through the planning period. If the new code/standard is more efficient than the average UEC in the baseline year, the Council will adjust and then re-freeze the baseline at the standard/code level for the remainder of the planning period.

Ultimately, the analyst needs a single estimate of the average energy consumed by each unit sold in the market, which reflects the distribution of sales across different efficiency levels (i.e., the efficiency mix). In the example in Table 1, the Council assumed that the average unit in the market would consume 135 kWh per year based on the estimated efficiency mix of 70% code minimum and 30% ENERGY STAR.

Table 1. Example Calculation of Baseline Energy Consumption

Efficiency Level	Annual UEC at Efficiency Level (kWh)	Baseline Efficiency Mix	Average UEC (Weighted by Efficiency Mix)	Annual Market Size for Year X (Estimated in Question 2)	Baseline Energy Consumption (kWh)
Code Minimum	150 kWh	70%	135 kWh	1,000	135,000 kWh
ENERGY STAR	100 kWh	30%			

Source: Research team analysis

Note: Data intended for illustrative purposes only

The analyst multiplies this estimate of average UEC (weighted by the Council Plan's assumed efficiency mix or by the actual efficiency mix shown in sales data for the baseline year) by the total market size as estimated in Question 2. The result of this calculation is the baseline energy consumption. This is the value to which the analyst compares actual market consumption (estimated in Question 3b) to estimate total market savings, and, later, Momentum Savings.

Question 3b: What was the energy use in the following years?

Question 3b estimates the energy consumption of the market in the years covered by the analysis period. Conceptually, Question 3b is the same as Question 3a but for a different period of time. Question 3a estimates the energy consumption of the market in the baseline year, which is the baseline consumption.

To answer this question, the analyst uses as much sales data as possible to estimate the efficiency mix of units actually sold during the analysis period. (The Chain Logic Method for Working with Sales Data chapter includes additional detail on the method used to estimate this efficiency mix.) The Council Plan assumes a frozen efficiency mix over time, but, in general, markets where programs operate become more efficient over time.

With the new data on actual sales, the analyst creates a table just as in Question 3a but replaces the baseline efficiency mix data with the newly estimated actual efficiency mix for each year of the analysis. (Table 2 includes an example.) The analyst determines the actual consumption in the same manner she calculated baseline consumption. The difference between actual consumption and baseline consumption in any given year equals the total market savings.

Table 2. Example Calculation of Actual Energy Consumption

Efficiency Level	Annual UEC at Efficiency Level (kWh)	Actual Efficiency Mix in Year X	Average UEC (Weighted by Efficiency Mix)	Annual Market Size for Year X (Estimated in Question 2)	Actual Energy Consumption (kWh)
Code Minimum	150 kWh	60%	130 kWh	1,000	130,000 kWh
ENERGY STAR	100 kWh	40%			

Source: Research team analysis

Note: Data intended for illustrative purposes only

Question 4: What are the program savings?

Since the actual energy consumption estimated in Question 3b is based on sales data that include high efficiency units incentivized by programs or influenced by NEEA initiatives, the analyst must subtract the savings from program-incentivized units from total market savings to derive Momentum Savings. Before doing this, the analyst must assess whether the programs calculated savings using the same baseline assumed in the Power Plan for that measure or market. Often, the two baselines are not consistent because different baselines serve different purposes.[11] The analyst, therefore, must adjust program savings to align with the baseline used in the Momentum Savings analysis, which may be the Council baseline or the adjusted baseline.[12]

[11] For example, lighting programs often use a pre-existing condition baseline rather than a current practice baseline due to the availability of identical lamp replacements and the frequency with which programs target whole system retrofits rather than replace-on-burnout lamp replacements. However, customers purchasing lighting outside of programs (and thus potentially contributing to Momentum Savings) may be making different purchase decisions than their program counterparts. The use of the current practice baseline allows the Momentum Savings analyses to better represent the total population of end-use customers, not just program participants. The non-residential lighting Momentum Savings analysis adjusted the program-reported savings to a current practice baseline by estimating the difference between the average efficacy of lighting sold in the baseline year (i.e., the current practice, consistent with the Sixth Plan baseline) and the average efficacy implied in the 2009 CBSA stock mix (a proxy for the pre-existing condition baseline), and then scaling the program savings estimates accordingly. See the Non-Residential Lighting Momentum Savings Calculation Methodology chapter for more details.

[12] The specific methods used to "true up" program savings to the baseline used in the Momentum Savings vary by market and are explained in more detail in the market-specific chapters at the end of this report.

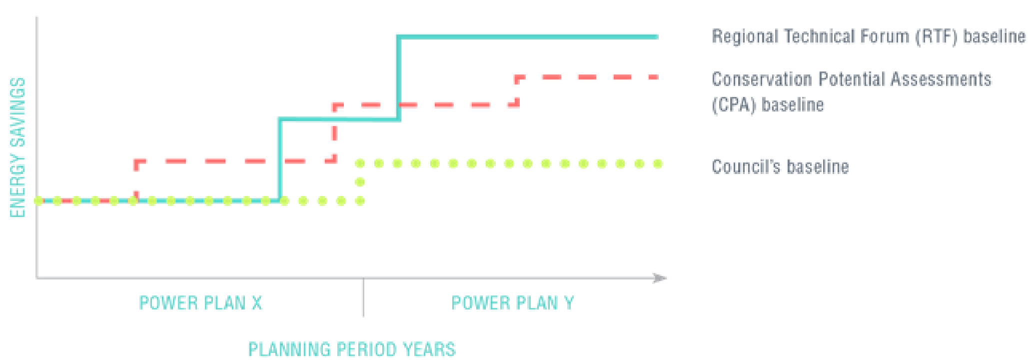
Different Baselines Serve Different Purposes

Independent of the Council's once-every-five-years baseline assumption, at least two other types of baselines shape the region's approach to efficiency. The Council's baseline serves as the foundation for calculating momentum savings. Policymakers, technical bodies, and utilities develop the other types of baselines so that conservation programs focus their resources on savings that would not occur in the absence of programmatic interventions. Two of the other key baselines are as follows:

1. The Regional Technical Forum (RTF) provides ongoing technical advisement on what baseline levels should be for many measures. The RTF continually updates these baselines as the market evolves. Programs adhering to the RTF's recommendations change their program baselines in accordance with the RTF updates.

2. Individual utilities, including many BPA customer utilities, may conduct their own conservation potential assessments (CPAs) with baseline assumptions outside of both the Council's and the RTF's baseline.

The three baselines—the Council baseline, the RTF baselines, and individual CPA baselines—need not be the same. The RTF measure baselines often increase over time as the market evolves to higher efficiency mixes (to a level higher than assumed in the Council baseline). This lowers the per-measure programmatic savings opportunity. Programs update their measure eligibility to follow these changing baselines because it ensures program cost-effectiveness. However, the per-measure savings opportunity relative to the Council baseline is unchanged because the Council baseline is frozen. The region's conservation achievement toward the target (including momentum savings) is always measured against the Council baseline.



If the market definition includes a market influenced by a NEEA initiative, the analyst must subtract any net market effects (savings) reported by NEEA from total market savings to estimate Momentum Savings.

This step of truing-up program baselines with the Momentum Savings baseline is crucial to ensuring that Momentum Savings are not double counted with program savings.[13]

[13] For more information, see the research team's memo *Methodology to Avoid Double-Counting in Momentum Savings Analyses.*

Finalization of Momentum Savings

BPA is currently developing an external review process to validate the approach and results of each Momentum Savings analysis. This external review process will help guide the decision to finalize a savings estimate or to pursue additional data collection and research. Currently, BPA makes that decision in concert with the research team based on sensitivity analyses and careful consideration of the model and its data sources. The research team will choose not to finalize a Momentum Savings analysis if they determine that the data and assumptions underpinning a key model input (i.e., one that has a significant impact on the savings) may be unreliable or if the model lacks transparency.

For example, BPA has held off on finalizing savings for the non-residential lighting and residential HVAC markets until the research team can collect additional data. On the residential HVAC project, the research team identified the need for additional research after conducting a sensitivity analysis on key model inputs. The sensitivity analysis revealed that the share of new HVAC units sold for conversions versus upgrades is a key driver of the savings results, and the research team's original assumption was based solely on professional judgment. The research team decided to conduct survey research to verify their assumption on this factor before finalizing the savings estimate.

The larger the Momentum Savings analysis, the more important it is to have a fully transparent model supported by robust data. In the non-residential lighting market, the research team decided to postpone finalization of the Momentum Savings estimate because the savings estimate was very large and the Excel-based model lacked sufficient transparency and the ability to assess uncertainty or conduct sensitivity analyses. The research team is developing a new analytical framework in a more appropriate platform that will improve certainty in the estimates and facilitate the review process.

Chain Logic Method for Working with Sales Data

This chapter discusses an analytical framework called the Chain Logic Method that BPA uses to estimate the **efficiency mix** of all products sold in a market. The efficiency mix is used to develop the average UEC of new units sold in the market, which is a key input into Question 3 of the Momentum Savings analysis—both in determining the actual energy consumption during the Plan period and in any baseline adjustment. This average UEC reflects the current practice in the market and is critical to program design, potential assessments, and Momentum Savings analysis.

As discussed above in the discussion of Question 3, to calculate the average UEC, the analyst needs two data points:

1. The range of efficiencies (and their corresponding UECs) available in the market
2. The share of total sales at each of the available efficiency levels (i.e., the market's efficiency mix)

The first data point is readily available in product lists and other data sources. The Chain Logic Method guides the analyst's attempt to estimate the second data point—the market's actual efficiency mix—which is typically more difficult to obtain and may require assumptions and triangulation of multiple data sources to fill in the gaps.

Actual sales data is the best source for estimating the mix of efficiencies sold in the market.

Unfortunately, sales data are often incomplete due to the sensitivity of the data, their proprietary nature, and wide dispersal across competitors within a market. Efficiency programs may collect sales data on the products they incentivize, but they rarely collect more than a limited subset of the total market. A series of data gaps is the inevitable result.

Data gaps would not be so problematic if all sellers sold the same mix of products and efficiencies.

Real-world variation in efficiency mixes of products sold by market actors means an analyst cannot simply assume that the average efficiency mix found in the incomplete sales data is representative of the total market.

The Chain Logic Method is a framework meant to address these problems by:

- Facilitating **methodological transparency** by providing a structural outline for reviewers to follow, making assumptions and data gaps explicit
- Ensuring a **rigorous analysis** by enabling the analyst (and the reviewer) to test the significance of the assumptions used to fill data gaps and highlight potential points for further research
- Allowing for **continuous updates** as new sales data become available, making it a valuable tool for the up-to-date tracking of a market.

Estimating the efficiency mix can and should involve many data points, sources, and assumptions, most of which are subject to uncertainty.

There is no concrete rule as to what constitutes an acceptable estimate. The acceptability of any estimate depends on the trade-offs between cost, speed, and the stakes associated with error. Transparency need not be one of those trade-offs. By focusing on sales data and using an updatable framework, the analyst does not need to sacrifice transparency and consistency at the expense of reliability. Ultimately, the Chain Logic Method facilitates a sharper understanding for policy makers of the trade-offs associated with these estimates' uncertainty.

The remainder of this chapter discusses the importance of the efficiency mix estimates and why sales data are the best measure of those metrics.

It also describes how the Chain Logic Method provides defensible efficiency mix estimates. An example of the residential lighting market illustrates key steps and components of the Chain Logic Method framework.

Residential Lighting Example

Gray text boxes throughout the chapter provide examples using the residential lighting market to illustrate key components of the method where appropriate.

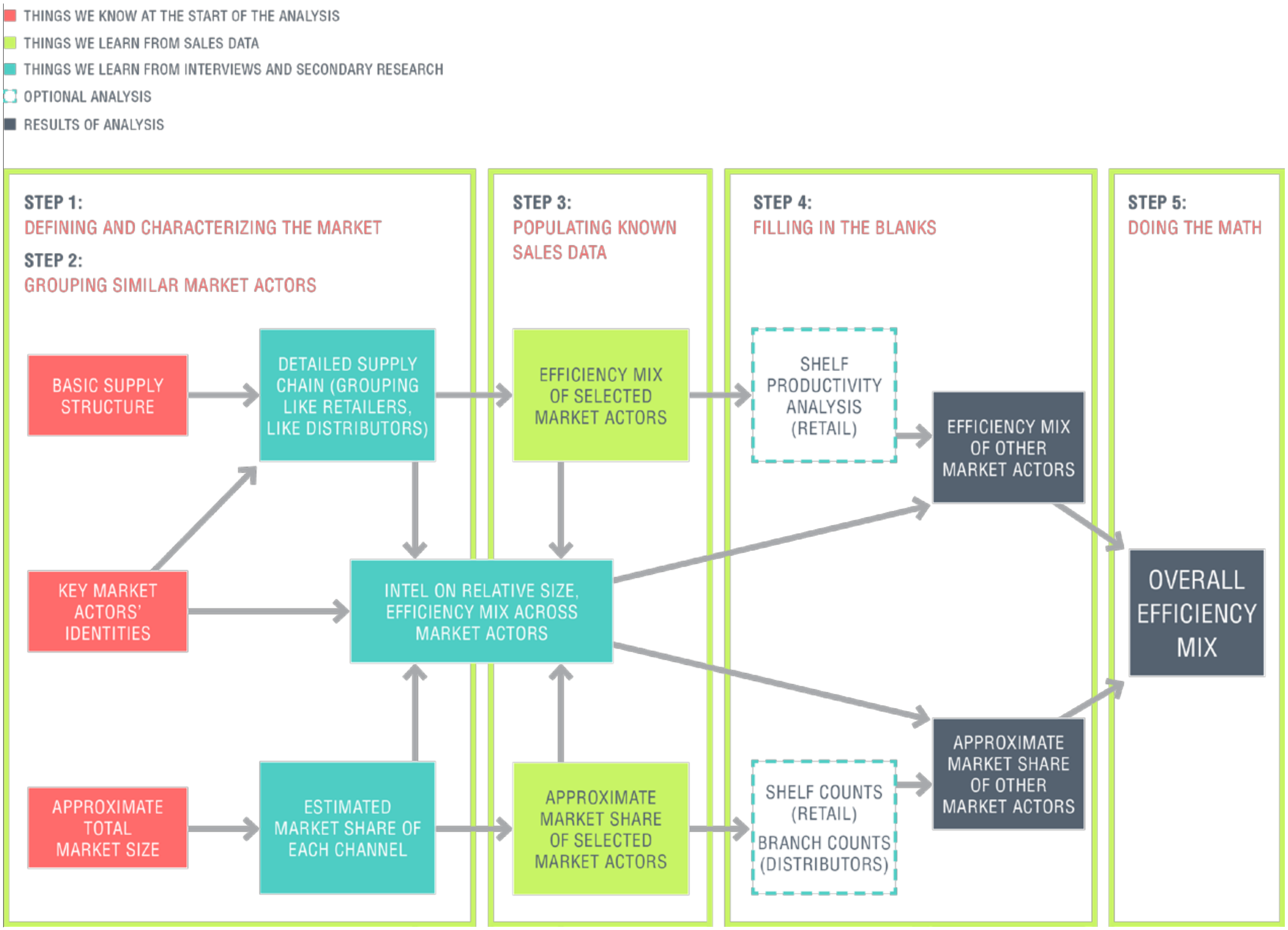
The remainder of this chapter describes the Chain Logic Method in detail, following the five steps[14] in the process:

- Step 1: Defining and characterizing the market
- Step 2: Grouping similar market actors
- Step 3: Populating known sales data
- Step 4: Filling in the blanks: market share and efficiency mix
- Step 5: Doing the math

Figure 6 provides an overview of the five steps and shows how the analyst synthesizes sales data, secondary research, and interview findings to estimate the overall market's efficiency mix.

[14] Note that Step 1 of the Chain Logic Method will likely have occurred during Question 1 of the overarching Momentum Savings Analysis Framework, in which the analyst defines the scope of the Momentum Savings analysis. The remainder of the Chain Logic Method relates specifically to Question 3 and the development of the weighted average UEC values, although it may also be used to answer Question 2 (annual market size) depending on the analysis.

Figure 6. Overview of the Chain Logic Method



Step 1: Defining and Characterizing the Market

The first step in the Chain Logic Method is to define the scope of the market and to characterize the flow of products through the market.

Understanding the market in question provides context for an analyst making assumptions around incomplete sales data. This includes defining both the scope of the market as well as the characteristics of the market, such as market channels and market actors.

Prior to applying the Chain Logic Method, the analyst will have already defined the scope of the market in Question 1 of the Momentum Savings analysis, including the products, applications, sectors, and geographies included within the scope of the analysis. The analyst will also have defined the efficiency levels within the market, particularly if the market includes multiple product types with varying energy use characteristics.[15]

Properly defining the market provides key insights and informed inferences about the gaps in existing sales data. For example, the definition of a product, such as "lamps," will vary greatly between the non-residential and residential lighting markets.[16] Without first defining the scope of the market, the analyst will not be able to clearly structure the Chain Logic Method analysis.

Residential Lighting Market Example

In this example, the market scope is defined as screw-in general purpose lamps installed in single family and multi-family homes in the Pacific Northwest. For simplicity, it is assumed that there are two efficiency levels—baseline and ENERGY STAR.

After defining the market, the analyst conducts market research to characterize the market. First, the analyst identifies the market channels, or paths from manufacturer to end-user. The most common channels include retail, distribution, and direct. Next, the analyst identifies the market actors that compete to bring the products to the end-users, including manufacturers, retail chains, and distributors, among others. Finally, the analyst characterizes the various types of product sold by each market actor, often through secondary research.

In summary, the three key questions necessary for characterizing the market are:

- What are the market channels? (Retail, distribution, direct from the manufacturer, etc.)
- Who are the market actors in each channel? (Do one or two market actors dominate the market or are there many small market actors?)
- What products and efficiency levels does each market actor sell?

By the end of Step 1 of the Chain Logic Method, the analyst develops a picture of both the scope and characteristics of the given market.

[15] The residential HVAC market is an example of a market that may include multiple product types or technologies that fulfill the same end-use, (e.g., electric forced air furnaces are the lowest efficiency level and various efficiencies of ASHPs are the higher efficiency levels).
[16] Whereas lamps may be a clear enough product definition in the residential market, it would not be a sufficient definition for the non-residential market, which is typically served by lamp-ballast systems.

This allows the analyst to build the analytical framework needed to complete the gaps in the sales data and group market actors according to shared attributes. Table 3 illustrates this framework and includes the known channels, market actors, and products for the market.

Residential Lighting Market Example

The example in Table 3 shows the main retailers: Retailers A, B, C, D and E, as well as an "Other" category that captures the remaining, smaller retailers. Four distributors dominate the distribution channel. Note that Retailer C advertises that they sell only ENERGY STAR bulbs.

Table 3. Framework Illustrating Specific Channels, Market Actors, and Efficiencies in the Selected Market

Channel	Market Actor	Efficiency Level
Retail	Retailer A	Standard Efficiency
		ENERGY STAR
	Retailer B	Standard Efficiency
		ENERGY STAR
	Retailer C	~~Standard Efficiency~~
		ENERGY STAR
	Retailer D	Standard Efficiency
		ENERGY STAR
	Retailer E	Standard Efficiency
		ENERGY STAR
	Other	Standard Efficiency
		ENERGY STAR
Distribution	Distributor A	Standard Efficiency
		ENERGY STAR
	Distributor B	Standard Efficiency
		ENERGY STAR
	Distributor C	Standard Efficiency
		ENERGY STAR
	Distributor D	Standard Efficiency
		ENERGY STAR
Direct	All Manufacturers	Standard Efficiency
		ENERGY STAR

Source: Research team analysis

Ultimately, the purpose of the Chain Logic Method is to estimate the market shares and efficiency mixes for each channel and each of these key market actors.

Step 2: Grouping Similar Market Actors

The next step is to determine which key market actors are likely to have similar efficiency mixes.

Each channel and market actor is unique. If the analyst has access to sales data for two retailers, she risks biased results if she assumes the efficiency mix of the two retailers adequately represents the entire retail channel. Thus, the analyst needs to consider which retailers are likely to have similar efficiency mixes and which she has good reason to believe may diverge from the efficiency mix evident in the sales data at hand.

First, the analyst will segment the market into groups of actors based on observable attributes. The analyst assigns all market actors to groups regardless of whether their sales data are available or not. The information necessary for grouping market actors may come from interviews, retailer websites, or secondary research.

Some considerations for grouping retailers include the following:

- Who is the retailer’s target customer?
- What is the retailer’s corporate strategy with regard to efficiency and price points?
- What mix of products and efficiencies does the retailer stock?
- How much of the retailer’s business is incentivized by utilities?

Ultimately, the analyst is looking to group retailers that can be assumed—based on observable characteristics—to have similar efficiency mixes.

The analyst can then extrapolate, within each group, the efficiency mix of the retailers for which sales data are available to other, similar retailers for which the analyst does not have sales data.

Residential Lighting Market Example

The example in Table 4 shows how the five main retailers can be grouped according to the markets they serve. Retailers A and B are big box retailers, while Retailers C and D are so-called “Do-it-yourself” (DIY) stores. Retailer E stands alone as a mass merchandise retailer.

Applying the efficiency mix of a mass merchandise retailer, such as Retailer E, to a big box retailer, such as Retailer B, would ignore the fact that Retailer E’s product mix is likely to be significantly less efficient because it targets a consumer who is likely to focus on cost over efficiency. However, the analyst could extrapolate Retailer A’s efficiency mix from Retailer B’s sales data because the two retailers are similar in terms of the products they sell and the markets they serve.

Table 4. Retailer Market Actor Categories

Channel	Category	Market Actor
Retail	Big Box	Retailer A
		Retailer B
	DIY	Retailer C
		Retailer D
	Mass Merchandise	Retailer E
	Other, Smaller Retailers	Other

Source: Research team analysis.

Analysts may use interviews or secondary research to answer the following questions to aid in grouping distributors:

- Scope of customers and products
    - What types of customers does the distributor serve?
    - What are the characteristics of the distributor's territory in terms of customer attitudes, climate, electricity cost, etc.?
    - What brands and models does the distributor carry?
- Business strategy for energy-efficient products:
    - Does the distributor offer only energy efficiency technology sales?
    - Does the distributor have a separate energy efficiency division?
    - Is the distributor a registered trade ally in utility efficiency programs?
    - Is energy efficiency a key part of their business strategy?
    - How much of the distributor's business is incentivized by utilities?

Residential Lighting Market Example

Keeping the above questions in mind, the analyst may gain insight into possible groupings of distributors through interviews and secondary research. This allows the analyst to group lighting distributors according to the categories that affect their efficiency mix. Table 5 shows how distributors in the residential lighting market could be binned. Past research efforts have shown that specialized, non-stocking, project-based distributors are typically more efficient than full service, stocking distributors. Therefore, the analyst must take care not to bin across these dimensions and only extrapolate product mix from market actors within each group. Given Distributor C's sales data, the analyst can apply their efficiency mix to Distributor D but not to Distributor A.

Table 5. Distributor Market Actor Categories

Channel	Category	Market Actor
Distribution	Maintenance, Replacement & Operations	Distributor A
	Full Line Electrical Distributor	Distributor B
	Lighting Distributor	Distributor C
		Distributor D

Source: Research team analysis

Market research efforts should keep this grouping in mind when developing interview guides and sample designs. Interviews with market actors and industry experts may be able to provide qualitative data on where other market actors (not included within the interview effort) may best fit into the defined groups; the analyst can use this to supplement secondary research to improve the groupings. Analysts should also anticipate not getting sales data from every market actor. Therefore, the goal should be to group similar distributors together for extrapolating the efficiency mix of one or two interviewed market actors to the remaining market actors within the same group.

Step 3: Populating Known Sales Data

The Chain Logic Method assumes the analyst has access to at least some sales data, no matter how incomplete.

The analyst can use a single market actor's sales data to estimate their efficiency mix (i.e., the percentage of sales at each efficiency level). If the analyst has an estimate of the total market size (perhaps from Question 2 of the Momentum Savings analysis), she can also estimate the market actor's relative market share. In Step 3, the analyst uses these data to populate the analytical framework.

Residential Lighting Market Example

The only sales data available to the analyst are Retailer B's regional lighting sales data. This example assumes only two efficiency levels: standard efficiency and ENERGY STAR. Retailer B's efficiency mix is 70% standard efficiency and 30% ENERGY STAR, and their total sales are 1,000,000 bulbs.

The analyst also knows from interviews and market research that Retailer C sells only ENERGY STAR bulbs and Distributor A does not sell any ENERGY STAR bulbs.

The analyst can begin populating the Chain Logic Method analytical framework with these data points (Table 6).

Table 6 displays the analysis framework populated with the fictional sales data identified in the residential lighting example.

Table 6. Placing Available Sales Data into the Chain Logic Method Analytical Framework

Channel	Share within Total Market (% of Units)	Category	Share within Channel (% of Units)	Market Actor	Share within Category (% of Units)	Market Actor Efficiency Mix (% ENERGY STAR)
Retail		Big Box Lighting Specialists		Retailer A		
				Retailer B (1,000,000)		30%
		DIY		Retailer C		100%
				Retailer D		
		Mass Merchandise		Retailer E		
		Other, Smaller Retailers		Other		
Distribution		Maintenance, Replacement, and Operations		Distributor A		0%
		Full Line Electrical Distributor		Distributor B		
		Lighting Distributor		Distributors C and D		
Direct		All Manufacturers				

Source: Research team analysis

Step 4: Filling in the Blanks: Market Share and Efficiency Mix

The following section describes how the analyst might extrapolate available sales data to fill in the gaps in the analytical framework. First, it describes how the analyst can use interviews and store counts to calculate market shares for each market actor. Then, it outlines quantitative and qualitative methods to estimate the efficiency mix sold by each market actor or group of market actors.

This step does not occur in a linear fashion but rather follows an iterative process using all known elements of the market. This is due to the varying degrees of confidence in market research information, uneven availability of data across the framework, and the extent to which different data elements are readily available.

Market Share

Once the analyst has populated all available sales data, Step 4 involves using various sources to fill in gaps in the analytical framework.

To extrapolate the available sales data, the analyst needs to develop estimates of the following:

- The market share of each key market actor within their market actor group (e.g., Retailer D's share of sales within the DIY retailer category)
- The market share of each market actor group within their channel (e.g., the DIY retailer category's share of sales within the retail channel)
- The market share of each channel within the overall market (e.g., the retail channel's share of all sales in the market)

The following sources provide the analyst with helpful information to develop these market share estimates:

Interviews. Finding and interviewing market actors who understand the market structure provides a quick and informative assessment of market shares of channels, market actor groups, and individual market actors. Rarely will one source have all the necessary answers. Instead, the combined insights from several market actors can help sharpen estimates and enhance the analyst's wider understanding of the market or guide the analyst toward better data sources. Ideally, interviewees include a variety of market actors, manufacturers, retailers, distributors, and other industry experts to create a comprehensive view of the market. Market actors near the beginning of the chain are best positioned to estimate the relative share of each channel.

Store counts. The analyst can also use proxies to inform the estimation of market shares. The analyst assumes that the number of stores each retailer has is proportional to their market share within a retailer group. For example, the analyst can calculate the relative market share of each market actor in a group by compiling the number of stores for every retailer as displayed on each retailer's website. Interviews at this stage can help refine estimates or confirm the accuracy of the market share proxy.

Residential Lighting Market Example

For example, within the Big Box Lighting Specialists category, the analyst can use the regional store counts of Retailers A and B as a proxy for their relative market share in the region. The analyst also knows the approximate market share of each channel from interviews with market experts and secondary research.

The analyst then inserts each market actor's market share as calculated in Table 7.

Table 7. Using Store Counts as a Proxy for Regional Market Share

Retailer Category	Share within Total Market	Store	Stores in NW	Share (of all Stores in Region)	Relative Market Share within Retailer Category
Big Box Lighting Specialists	50.0%	Retailer A	40	19.5%	57%
		Retailer B	30	14.6%	43%
DIY	17.5%	Retailer C	20	9.7%	66%
		Retailer D	10	4.9%	34%
Mass Merchandise	17.5%	Retailer E	5	2.4%	100%
Other, smaller retailers	15.0%	Other	100	48.9%	100%
Total Retail Channel	100%	Total	205	100%	

Source: Research team analysis

From interviews and secondary research

From retailer websites

Table 8. Insert Market Shares into Framework Table

Channel	Share within Total Market (% of Units)	Category	Share within Channel (of Units)	Market Actor	Share within Category (of Units)	Market Actor Efficiency Mix (% ENERGY STAR)
Retail		Big Box Lighting Specialists	50%	Retailer A	57%	
				Retailer B (1,000,000)	43%	30%
		DIY	17.5%	Retailer C	66%	100%
				Retailer D	34%	
		Mass Merchandise	17.5%	Retailer E	100%	
		Other, Smaller Retailers	15%	Other	100%	
Distribution		Maintenance, Replacement, and Operations		Distributor A		0%
		Full Line Electrical Distributor		Distributor B		
		Lighting Distributor		Other		
Direct		All Manufacturers				

Source: Research team analysis

Based on store counts as shown in Table 7

Additional sources. Sources such as published financial information in annual reports can be a good indicator of market share. It is usually broader in scope than the market of interest (e.g., lighting instead of residential lighting), so the analyst must take care to break out the specific market segment of interest. The specific data sources the analyst will use in the Chain Logic Method will vary by market based on the structure of the market and the types of data available.

Efficiency Mix

The next major element of market analysis is to address the efficiency mix for the remaining market actors in the selected market. This section discusses two channels (retail and distribution) and explores two approaches for determining the efficiency mix within each channel: quantitative and qualitative.

Addressing the Retail Channel

The retail channel aligns best with the example that this chapter has pursued in the residential lighting market. This discussion explores the quantitative and qualitative methods for estimating the efficiency mix in the residential market.

Quantitative approach: In a quantitative approach, the analyst finds an observable and quantifiable metric that correlates with sales of a given product. For example, in residential lighting, the analyst could conduct a shelf survey of a retailer for which she has sales data and develop a quantitative relationship between shelf space devoted to ENERGY STAR bulbs and sales of ENERGY STAR bulbs (as well as the relationship between standard efficiency bulbs' shelf space and sales). This quantitative relationship is called the relative productivity of the retailer's shelf space. The analyst could then conduct a shelf survey at retailers for which she does not have sales data and apply the calculated relative productivity to estimate the efficiency mix of these retailers. This approach assumes that there is a predictable quantitative relationship between the percentage of sales at each efficiency level and the percentage of shelf space devoted to that efficiency level across different retailers.

Residential Lighting Market Example

The analyst already has sales data revealing Retailer B's efficiency mix but must consider how the product mix of other market actors might differ from Retailer B. The analyst can calculate the relative productivity of Retailer B's shelf space (how shelf space dedicated to a given product translates into sales for that same product) if the available data reveals that Retailer B has 40% of its shelf space dedicated to baseline lamps and 60% dedicated to ENERGY STAR lamps, and this produces 70% baseline and 30% ENERGY STAR lamp sales. In this example, the baseline lamps produce a disproportionate share of the retailer's sales relative to baseline lamps' share of shelf space. This relative productivity is then applied to Retailer C's shelf space mix of 10% baseline and 90% ENERGY STAR, which produces 42% ENERGY STAR and 58% baseline sales.

Table 9. Relative Productivity Calculation

	Retailer B			Retailer A	
Efficiency Level	Retailer B Sales (Efficiency Mix)	Retailer B Shelf Space	Relative Productivity	Retailer A Shelf Space	Retailer A Sales (Efficiency Mix)
ENERGY STAR	30%	60%	29%	90%	**42%**
Standard Efficiency	70%	40%	350%	10%	**58%**
Total	100%	100%	n/a	100%	**100%**
Source	*Sales Data from Retailer B*	*Shelf Survey*	*Calculation (see* Appendix A: Sales Data Formulae for Chain Logic Method*)*	*Shelf Survey*	*Calculation (see* Appendix A: Sales Data Formulae for Chain Logic Method*)*

Source: Research team analysis

Qualitative approach: Observable quantitative metrics may not be available or may carry a high level of uncertainty. In such cases, the analyst can examine how other retailers compare to Retailer B using a variety of qualitative indicators, including the following:

- Target customers
- Promotions
- Corporate pledges
- Supplier relationships

The analyst can also find other sources that may provide clues about a company's product mix online, in news articles, in trade magazines, or in company's sales literature. For example, a given retailer might only sell one product type or might commit to only selling products above a certain efficiency level.

Residential Lighting Market Example

Retailer C made a pledge to sell only ENERGY STAR lamps. Therefore, the analyst can assume Retailer C's product mix is 0% baseline and 100% ENERGY STAR.

The analyst may also know from interviews and secondary research that Retailer A and Retailer B have similar market shares and target the same demographic. The analyst may then reasonably assume that the two have a similar product mix. However, it turns out that Retailer A has been running a promotion for ENERGY STAR lamps for the past six months. In this case, the analyst adjusts the product mix to reflect the fact that Retailer A would likely have higher ENERGY STAR sales as a result of the promotion, perhaps 60% baseline and 40% ENERGY STAR.

Addressing Other Channels: Distribution

Rarely does the entire market flow through a single channel (e.g., retail). Therefore, the analyst must identify and investigate all channels through which the product flows.

Residential Lighting Market Example

The next step is to determine how much does not go through retail. Research and interviews revealed approximately 95% of residential general purpose lamps are sold through retailers. When one channel so dominates a market, the analyst first must evaluate the importance of the non-dominant channel. If only 5% of total residential lamp sales are unaccounted for, does the product mix of those 5% really matter to the analysis? If it does matter, the analyst must gather at least one distributor's sales data.

Quantitative approach: Similar to the quantitative approach described for the retailer channel, the analyst must seek an observable metric—or one that the analyst could develop through interviews or secondary research—that she could obtain for the distributors for whom she doesn't have sales data. The analyst could conduct a factor analysis to determine which distributor characteristics likely correlate with a higher or lower efficiency mix. The grouping of like distributors that took place in Step 2 is a good starting point for this factor analysis. If the analyst has sales data for at least one distributor in each group, she could extrapolate that distributor's efficiency mix to other similar distributors within the same group. Interviews with distributors, other market actors such as contractors and retailers, and market experts could aid the analyst in determining on what factors this extrapolation should or should not be based. For example, interviews and analysis of the available sales data may reveal that there is a significant difference in efficiency mixes between rural and urban distributors, so the analyst would want to take care not to extrapolate a rural distributor's efficiency mix to an urban distributor, even if they are similar on other factors.

Qualitative approach: With no access to sales data from distributors, the analyst must consider what factors might contribute to the distributors having a different efficiency mix than the retail sector. The analyst conducts interviews to understand the customer types served through distribution of the product of interest.

Distributor product lists can provide the analyst with additional clues about a given distributor's product mix. For example, the analyst can sort model numbers found on the product list according to whether or not they meet a certain threshold, such as qualification for the ENERGY STAR specification.

Residential Lighting Market Example

The analyst seeks to determine to whom distributors sell residential lamps. Perhaps home builders or small hardware stores would purchase from distributors; large hardware stores would generally buy directly from manufacturers. The analyst then conducts interviews and research to determine how these customers differ from those served in the retail sector. The answer will qualitatively inform assumptions about how to adjust product mix for distribution as compared to retail.

Step 5: Doing the Math

The analyst now populates the analysis framework with relative and absolute estimates. In addition, the analyst conducts further research or sensitivity analyses on the less reliable data points to estimate ranges around point estimates. The final step is to multiply out each individual efficiency mix (e.g., percentage of sales that are ENERGY STAR) to compute a final efficiency mix. By weighting each market actor's ENERGY STAR percentage by their market share within their category, then weighting each category's share within its channel, and each channel's share within the total market, the analyst can estimate the percentage of total market sales that are ENERGY STAR.

Table 10. Final Calculations

Channel	Share within Total Market (% of Units)	Category	Share within Channel (% of Units)	Market Actor	Share within Category (% of Units)	Market Actor Efficiency Mix (% ENERGY STAR)	Efficiency Mix Data Sources
Retail	95%	Big Box Lighting Specialists	50%	Retailer A	57%	40%	*Relative Productivity of Shelf Space*
				Retailer B (1,000,000)	43%	30%	*Sales Data*
		DIY	17%	Retailer C	66%	100%	*Secondary Research*
				Retailer D	34%	50%	*Relative Productivity of Shelf Space*
		Mass Merchandise	17%	Retailer E	100%	60%	
		Other, Smaller Retailers	16%	Other	100%	25%	
Distribution	4%	Maintenance, Replacement, and Operations		Distributor A	50%	0%	*Interviews and Secondary Research*
		Full Line Electrical Distributor		Distributor B	25%	40%	
		Lighting Distributor		Other	25%	10%	
Direct	1%						*Interviews and Secondary Research*
Sources for Market Shares:	*Interviews*	*Interviews and Secondary Research*		***Retailers:*** *Sales Data, Store Counts as Proxy of Market Share* ***Distributors:*** *Interviews and Secondary Research*			

Source: Research team analysis