

Estimating the Impact of DSM on Energy Sales Forecasts

A Survey of Utility Practices

PRESENTED TO

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THE **Brattle** GROUP

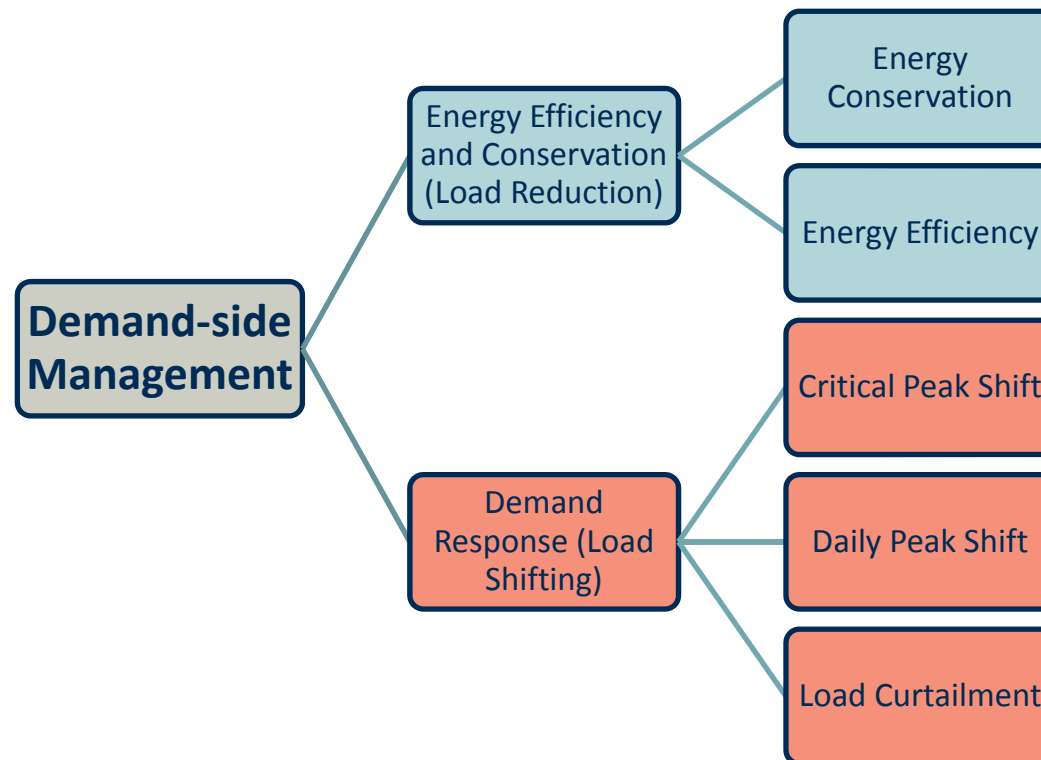
Agenda

For the past few years, utilities have been consistently over-forecasting sales, and one of the main reasons is DSM

We describe several different approaches to estimating the impact of DSM on sales, based on conversations with several utilities in 2013 and 2016

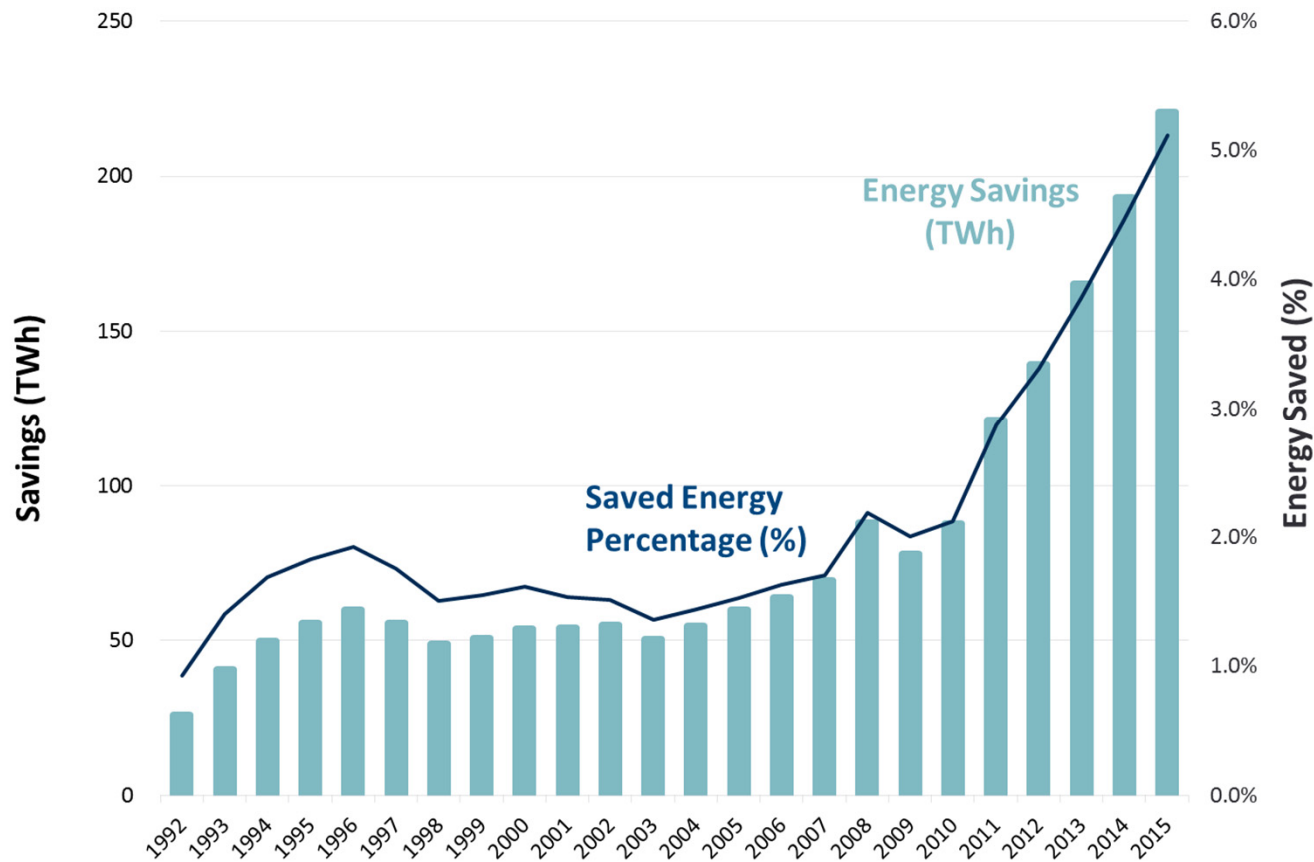
What is Demand-side Management (DSM)?

Demand-side management (DSM) refers to programs and technologies encouraging customers to modify their level and pattern of electricity usage.



Increased Penetration of DSM throughout the U.S.

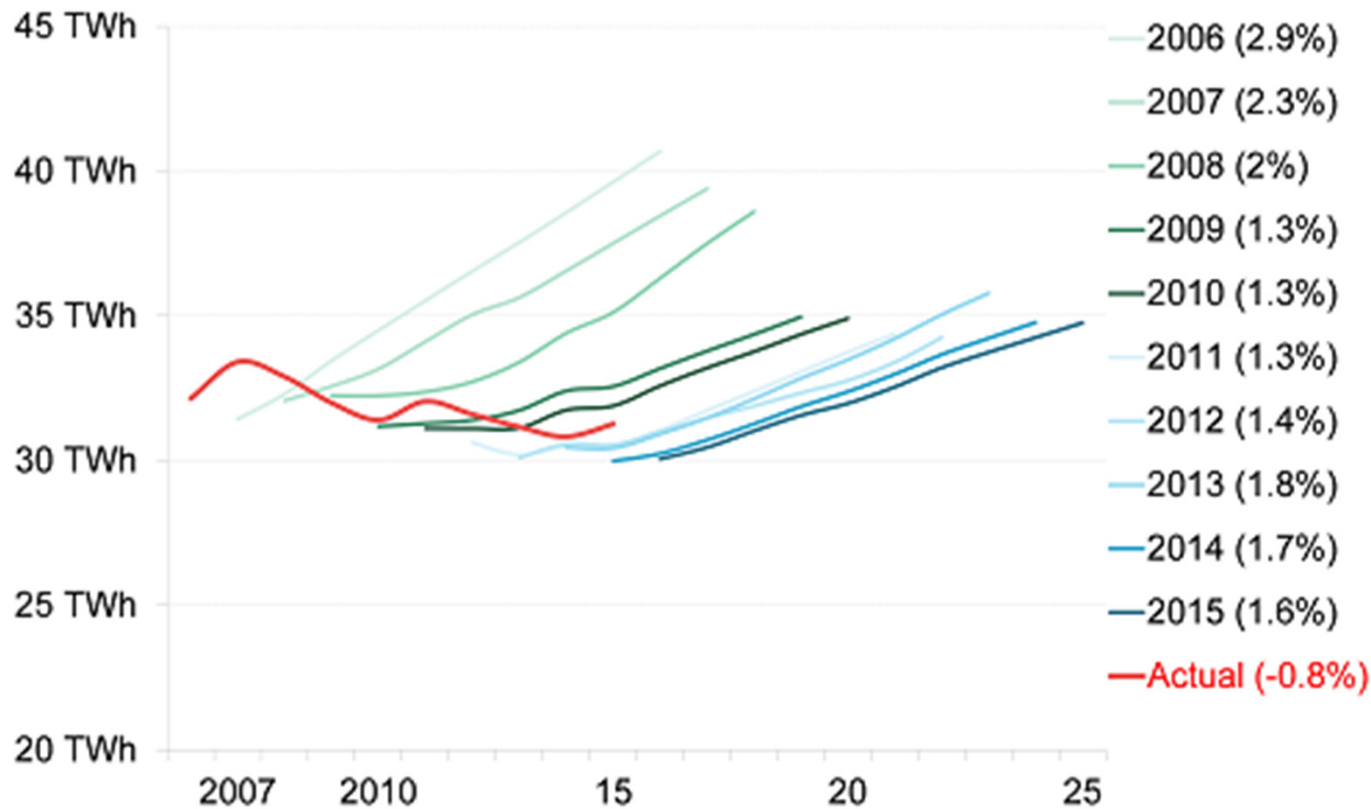
Energy Savings from DSM in the U.S., 1992-2015



Source: Form EIA-861 data. Energy Saved Percentage is calculated as DSM Savings/Total Sales.

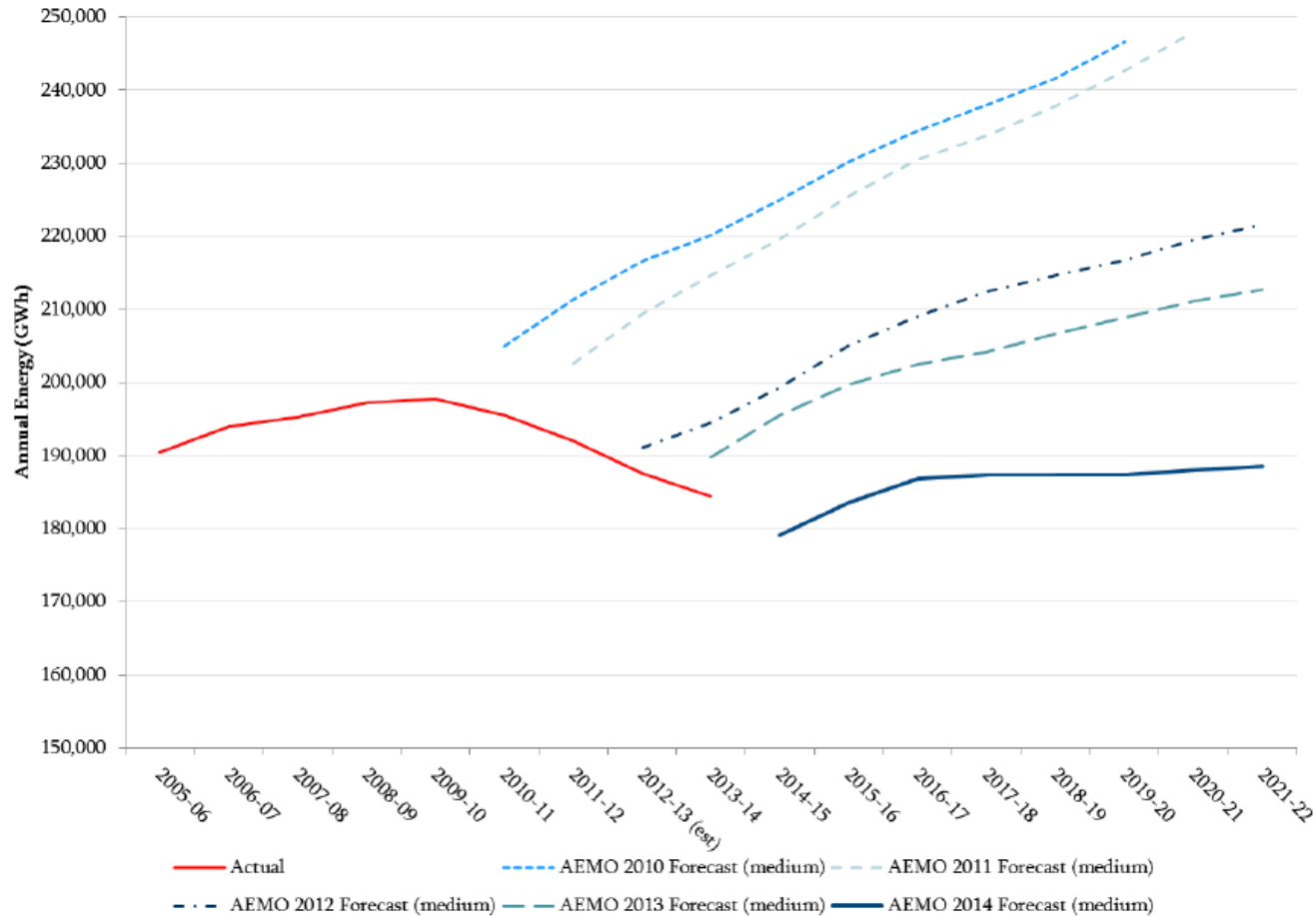
Utilities have Consistently Over-Forecasted Sales Due to Factors Like DSM

A Typical Utility Actual Sales and Load Forecasts, 2006 -2015

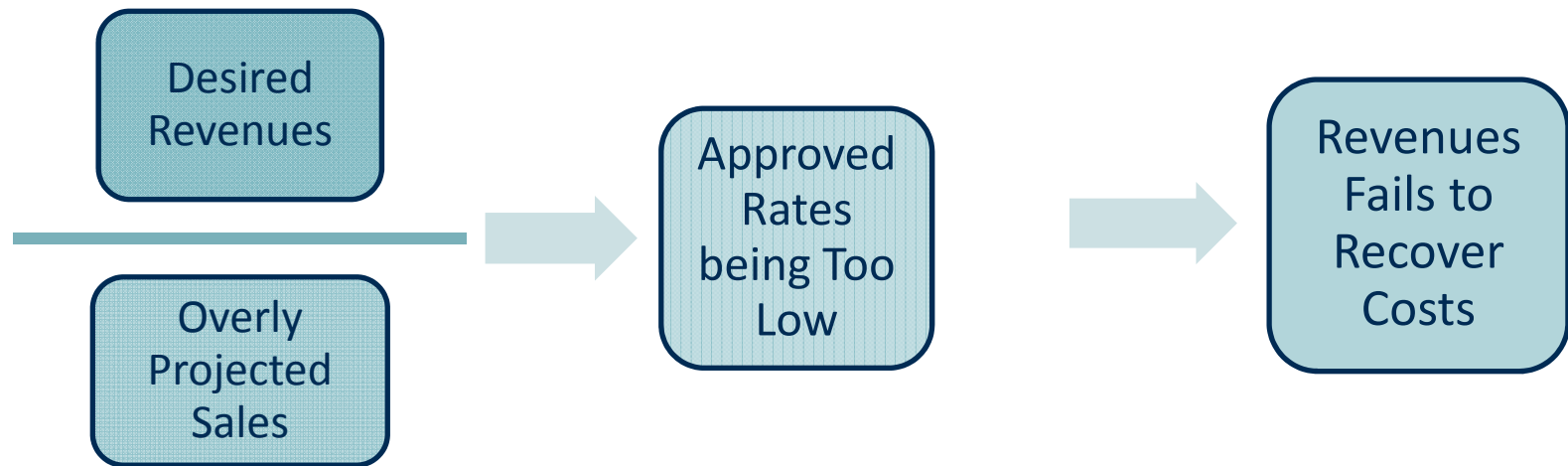


Similar Trends Have Been Observed Outside the U.S.

AEMO – National Energy Market, Actual and Forecasted Energy Sent out



Over-forecasting Sales leads to Approved Tariffs to be Too Low to Recover the Desired Revenues



Key Challenge in Estimating the Impact of DSM on Load Forecasts

It is hard to determine how much, if any, DSM is accounted for in the historical sales data

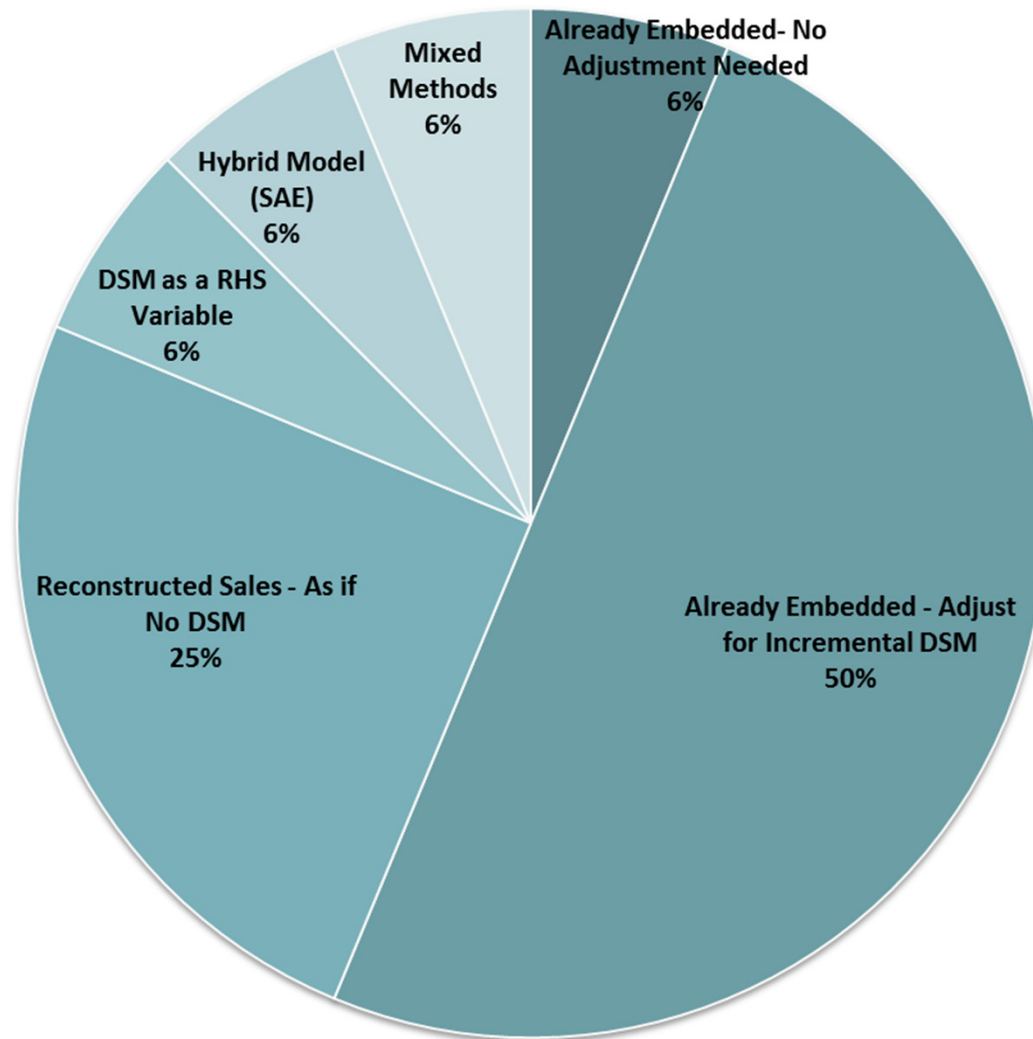
- The impacts from the DSM are mixed with customer's naturally occurring conservation and impacts from government codes and standards

Brattle Surveyed 16 North American Utilities in 2013

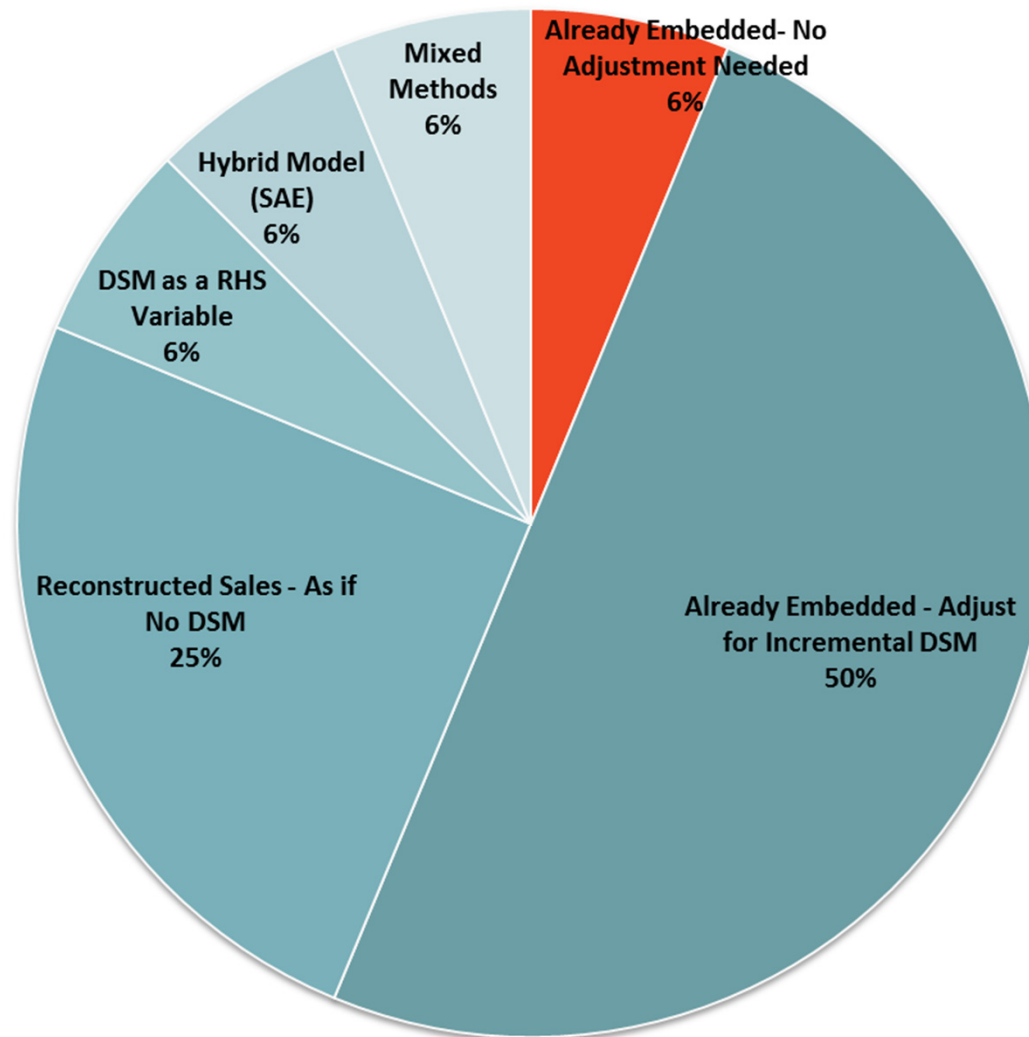
The 2013 Survey:

- Do you make any exogenous adjustment to your load forecast for DSM?
- If so, what are the methodologies used?

Brattle 2013 Survey of Utilities on Handling DSM



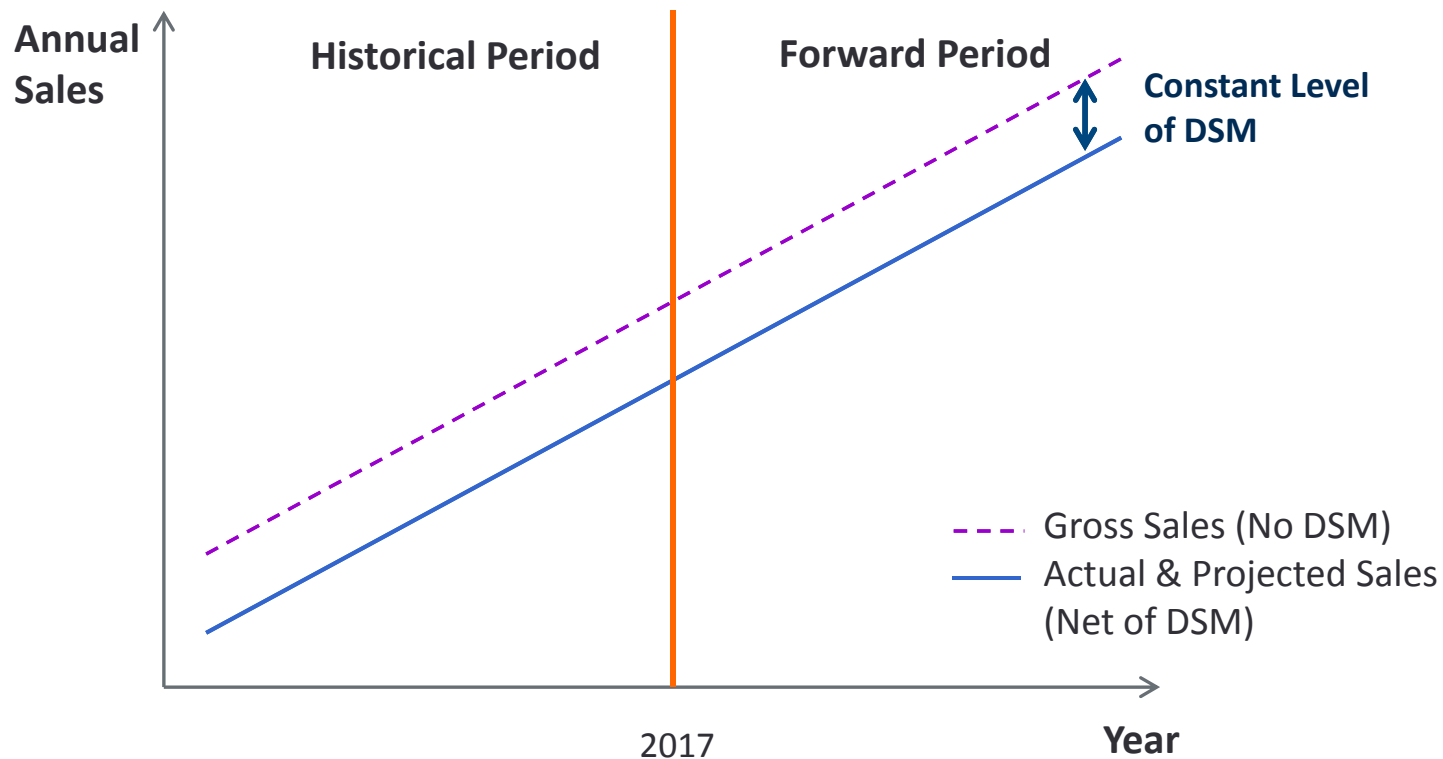
Approach 1: DSM Already Embedded in Sales Data - No Post-regression Adjustment Needed



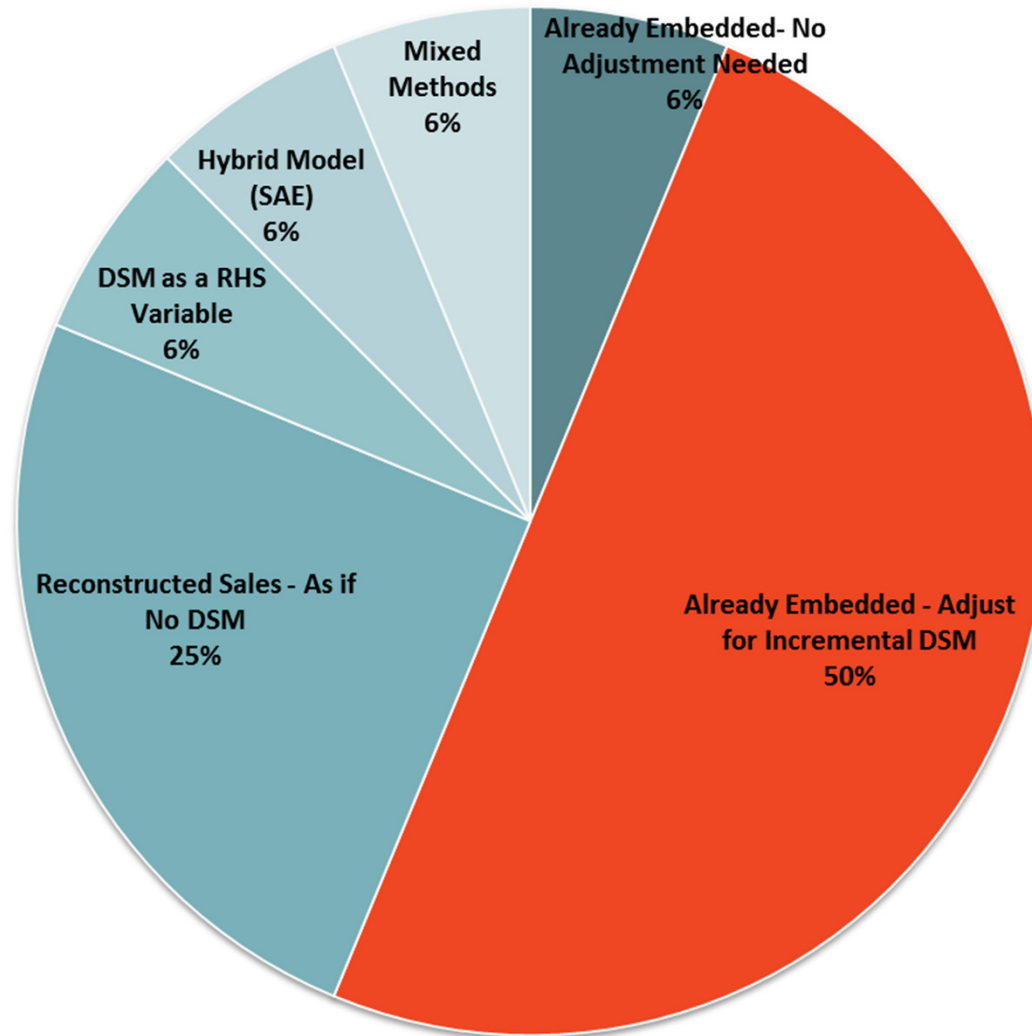
Approach 1: DSM Already Embedded in Sales Data - No Post-regression Adjustment Needed

This approach has been used by utilities when

- There is no history of DSM and no expected DSM activity in the future
- There was some DSM activity but its intensity remained constant historically and was expected to stay at the same pace in the future



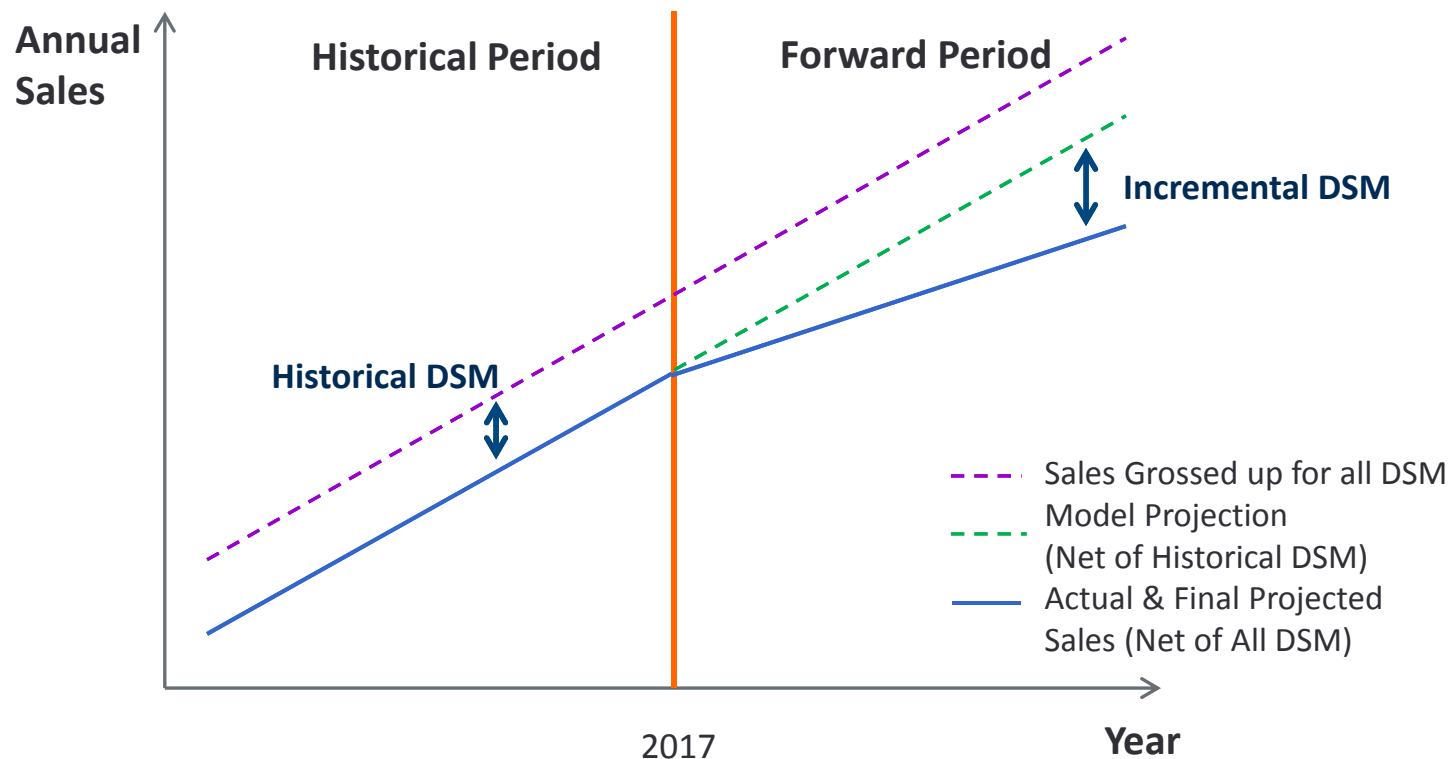
Approach 2: Historical DSM Already Embedded in Sales Data - Need Adjustment for Incremental DSM



Approach 2: Historical DSM Already Embedded in Sales Data - Need Adjustment for Incremental DSM

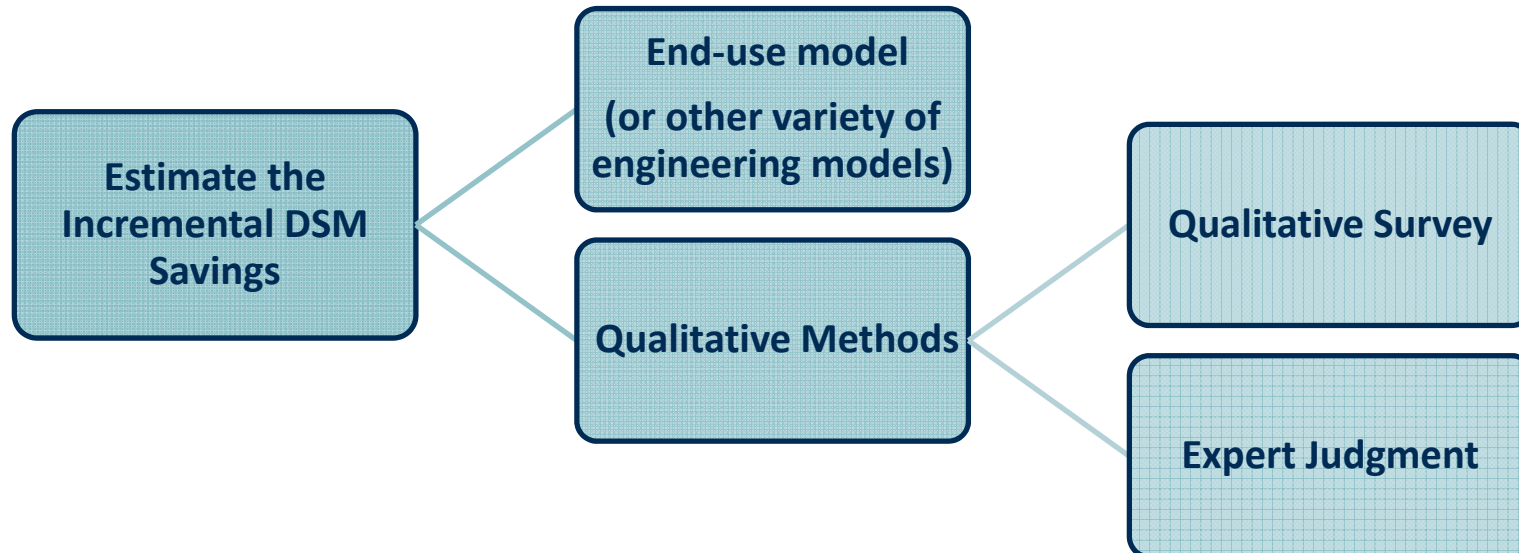
This is the most widely used approach among North American utilities

- No prior history of DSM but with projected DSM in the future
- Constant historical DSM but with an incremental DSM in the future

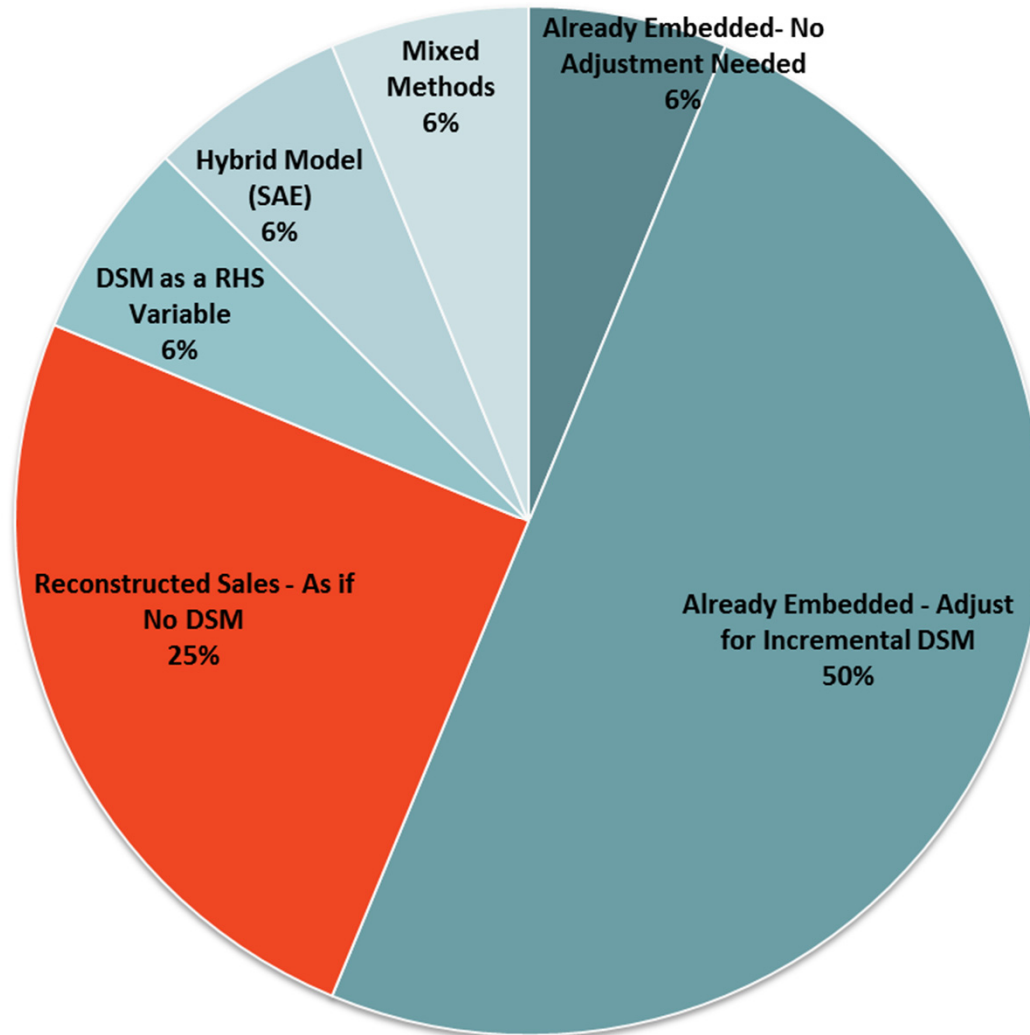


The Second Approach Relies on an Exogenous Estimate of Incremental DSM Savings

The incremental DSM savings are estimated outside the load forecasting models

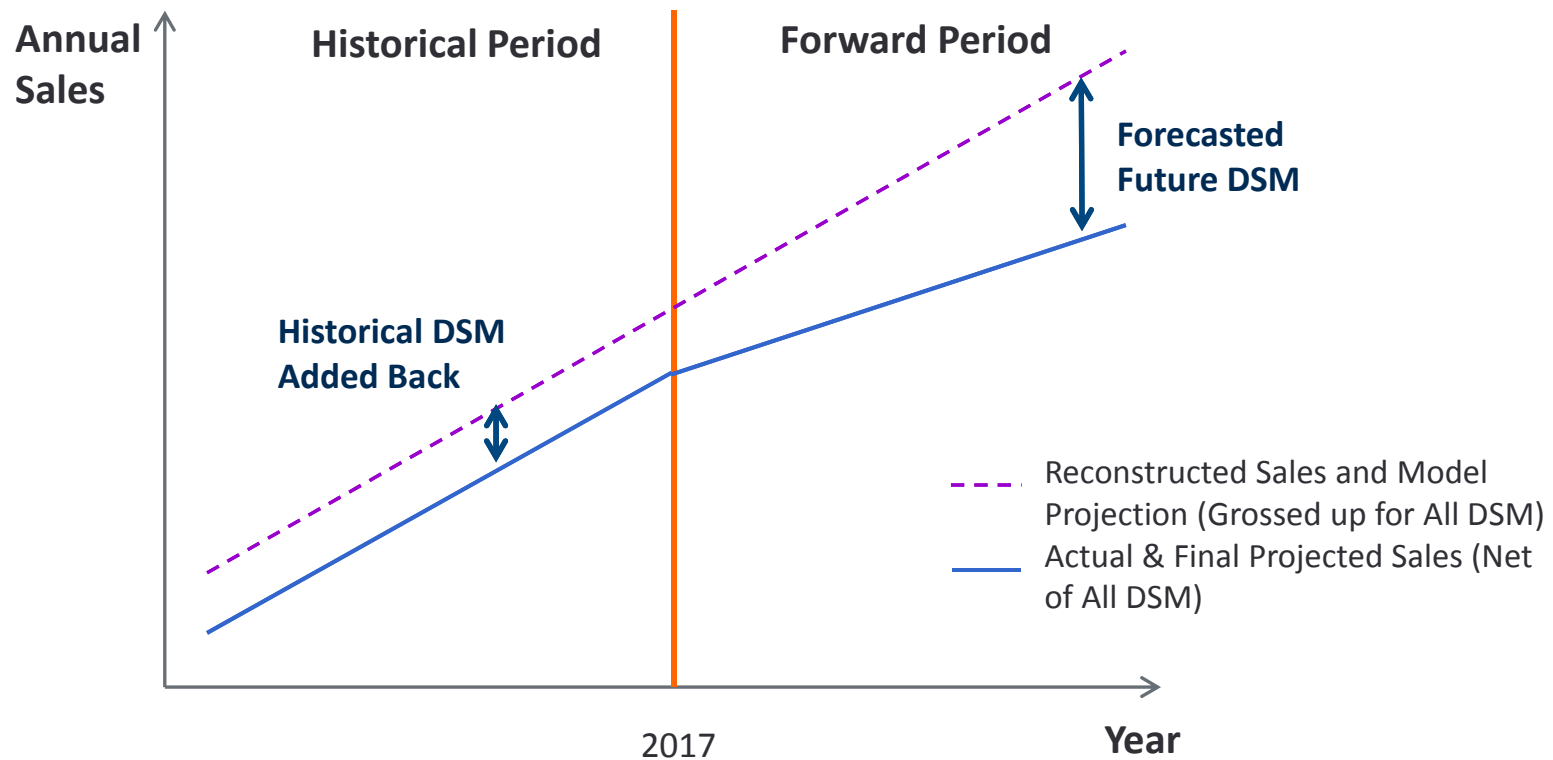


Approach 3: Reconstruct Historical Sales – As if No DSM

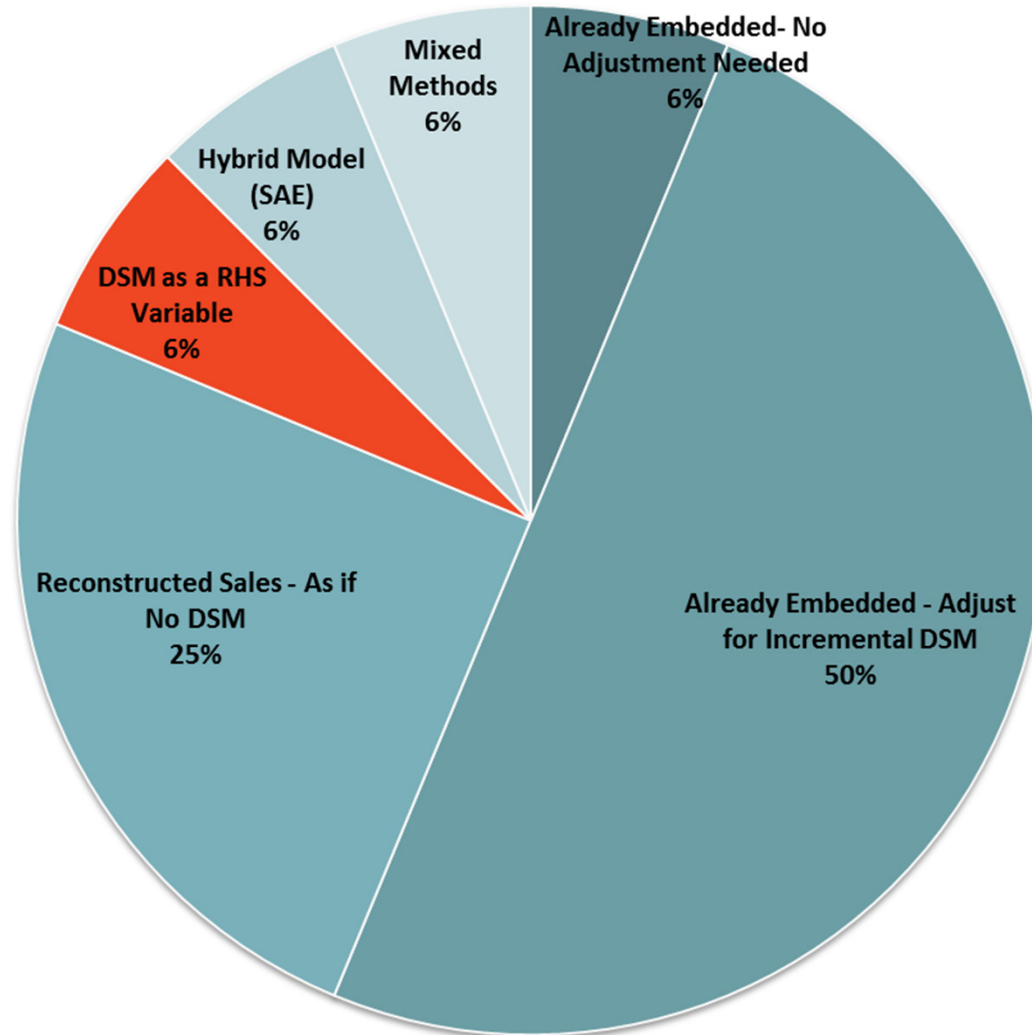


Approach 3: Forecast with Reconstructed Sales as if no DSM and Do Post-regression Adjustment

- The main reason for utility companies to adopt this approach is that there are considerable change in the intensity of DSM programs during the past few years
- It still requires estimates of DSM impacts from either end-use models or qualitative surveys
- The forecast accuracy from this approach, to a great extent, depends on the accuracy of DSM impacts estimates



Approach 4: Include DSM Activities as a Right-hand Side Variable in Econometric Models



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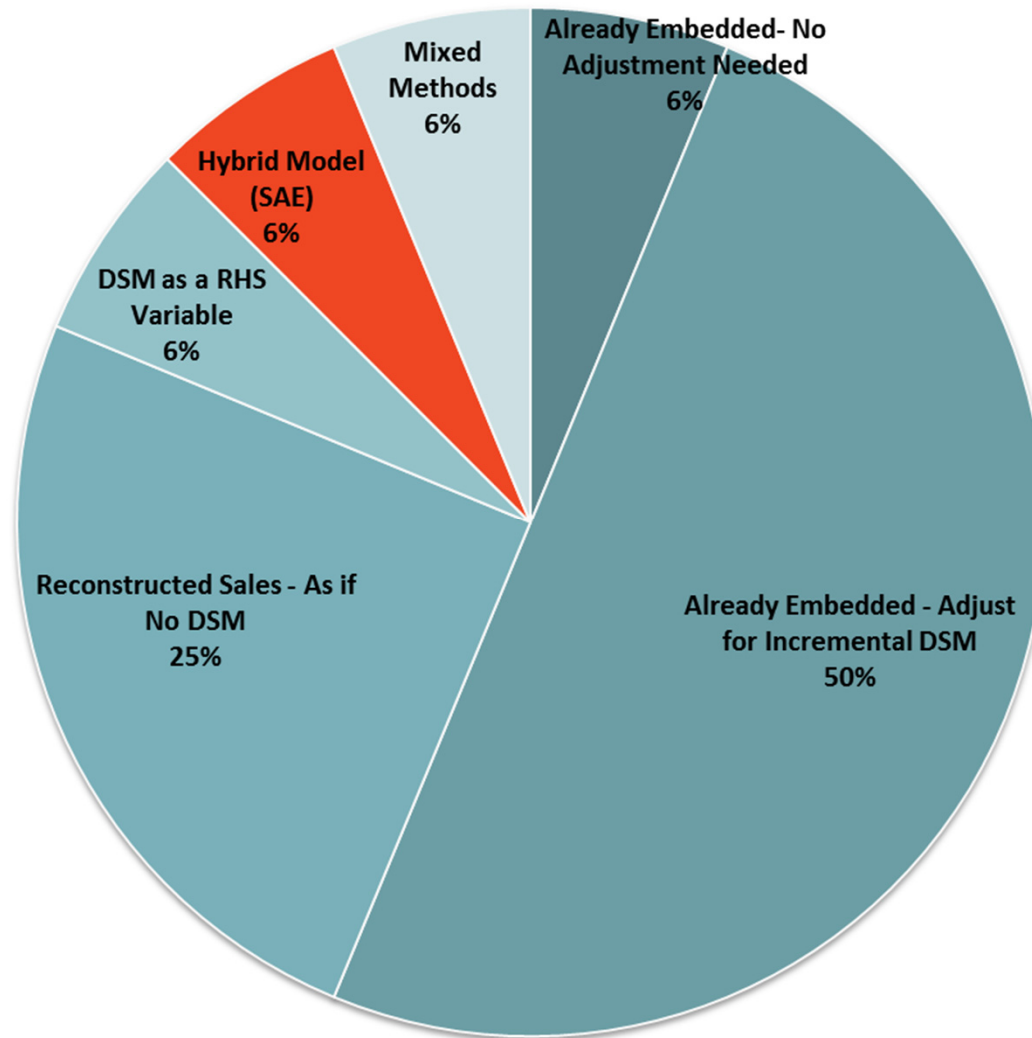
This approach explicitly accounts for the impact of DSM by introducing DSM variable as a right-hand side variable in the econometric model.

- It does not rely on exogenous estimates of DSM impacts like Approach 2 and 3; instead, it estimates its own DSM impacts within the econometric models

- Utilities need to collect data of potential DSM variables which can be time consuming or even infeasible

- Choices of DSM variables:
 - Expenditures (\$ spent) of DSM programs
 - Number of customers involved in the programs
 - Binary variables if expenditures are not quantifiable

Approach 5: Develop a Hybrid Model (SAE) that Embeds End-use Features in Econometric Models

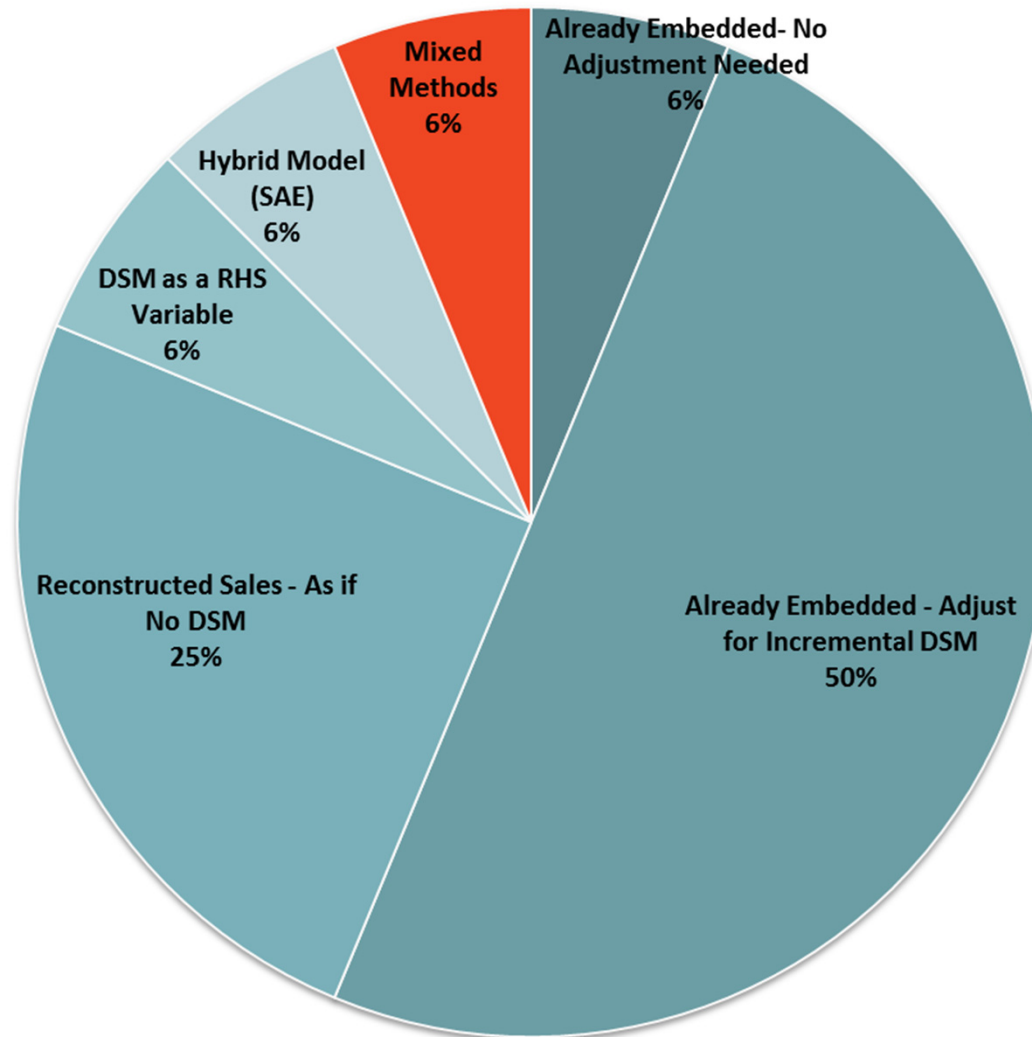


Approach 5: Develop a Hybrid Model (SAE) that Embeds End-use Features in Econometric Models

A hybrid model approach combines end-use models with econometric models

- End-use concepts are applied as model variables in the regression equation which allows the model to account for naturally occurring changes in DSM
- Such models reap the benefits of econometric models and end-use models, with fewer time and resource requirements than a traditional end-use model
- Statistically adjusted end-use (SAE) models are an example of this approach

Approach 6: Used a Combination of Approaches Discussed Above



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Utilities choose to use a combination of approaches for various reasons

- Short-Term Forecasting v.s. Long-Term Forecasting
 - Short-term (1-2 years): Approach 1
 - Long-term (> 3 years): Approach 2
- Choose Different Approaches Based on Rate Classes and Jurisdictions
- Use Another Approach as Cross Check

Advantages and Disadvantages

	Advantages	Disadvantages
Already Embedded – No Adjustment Needed	Easy to Implement	Only Useful with Limited and Stable DSM
Already Embedded – Adjust for Incremental DSM	Easy to Implement; Can Account for Increase in Intensity of DSM	Need to Estimate Exogenous DSM Savings Outside the Sales Forecast Models
Reconstructed Sales – As if No DSM	Can Account for Considerable Changes in Historical DSM	Forecast Accuracy Depends on Accuracy of the Estimates of DSM Savings
DSM Activities as a RHS Variable	No Need to Estimate Exogenous DSM Savings	Data Hard to Acquire
Hybrid Model (SAE)	Capture both Naturally Occurring Efficiency Trends and DSM Impacts	Need Sophisticated Software and Trained Personnel to Execute
Combination of Approaches Above	Can Reap the Benefit of Multiple Approaches	Costly to Implement

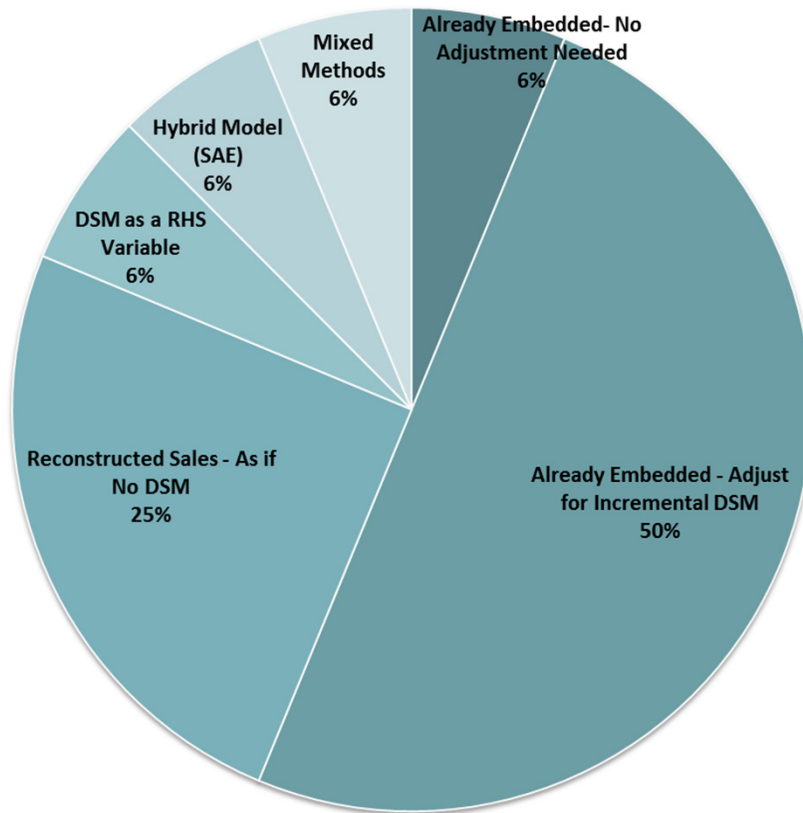
Brattle Conducted a Second Survey in 2016

The 2016 Survey:

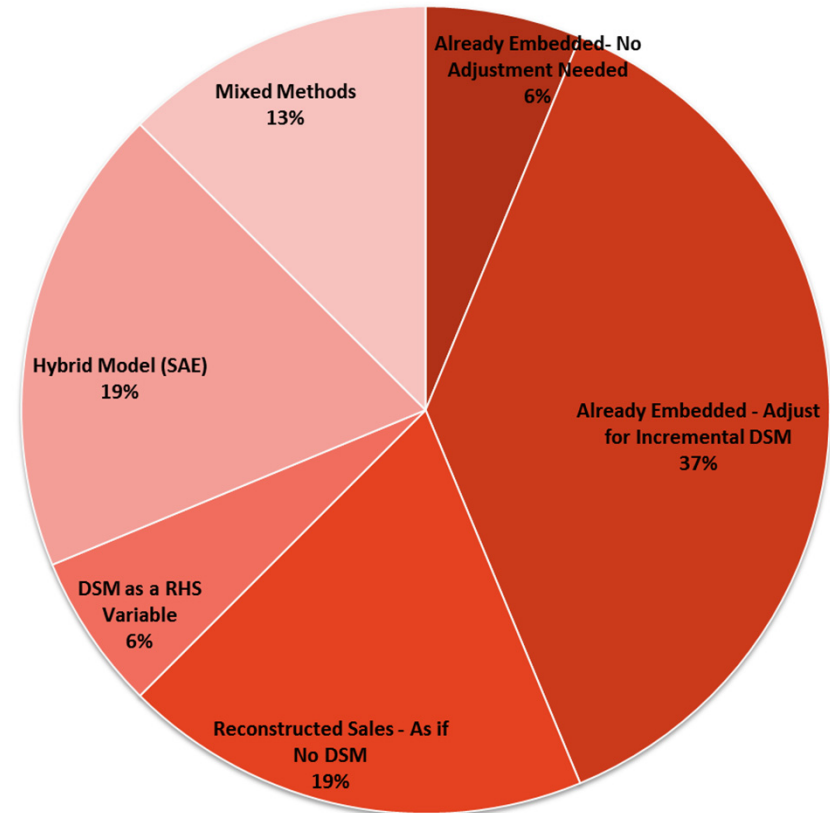
- What approach are you using to incorporate DSM into your sales forecast?
- Is this the same approach you were using four years ago?
- If not, why did you make the change?
- How satisfied are you with your approach?
- Has the approach been accepted by the regulatory body?
- If you are estimating DSM impacts outside of an econometric model, are you using an end-use model to estimate them?

Brattle Survey Results Comparison

2013



2016



Brattle Survey Results

Four utilities switched to a different approach

- SAE model gained popularity among utilities especially for long-term forecasting
- More utilities adopted mixed approaches

Rationale behind the switches

- Increased intensity of DSM programs
- More years of DSM variables data becomes available
- Improvements in software

Conclusions

- Forecast sales with impact of DSM is a challenging yet crucial task to utilities
- Six approaches adopted by utilities to account for DSM
- Utilities should understand the advantage/disadvantage of each approach and choose the best one based on
 - The nature of the DSM programs
 - Data availability
 - Change in time may warrant another review
- Similar method can be applied to DG and government mandated Codes and Standards

Presenter Information



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Ahmad Faruqi leads the firm's practice in understanding and managing the changing needs of energy consumers. This work encompasses tariff design and evaluation, distributed generation, energy efficiency, demand response, demand forecasting and cost-benefit analysis of emerging technologies. He has consulted with more than 125 clients, including utilities, system operators, and regulatory commissions, in the U.S. and in Australia, Canada, Egypt, Hong Kong, Jamaica, Philippines, Saudi Arabia, and Thailand. He has filed testimony or appeared before state commissions, government agencies, or legislative bodies in Alberta (Canada), Arizona, Arkansas, California, District of Columbia, Illinois, Indiana, Kansas, Maryland, Michigan and Ontario (Canada). He has spoken at conferences in Australia, Bahrain, Brazil, Egypt, France, Germany, Ireland, Jamaica, and the United Kingdom. And his work has been cited in *Business Week*, *The Economist*, *Forbes*, *The New York Times*, *USA Today*, *The Wall Street Journal* and *Washington Post*. He has appeared on Fox News and National Public Radio and is the author, co-author, or co-editor of four books and more than 150 articles on energy economics. Dr. Faruqi holds bachelors and masters degrees from the University of Karachi in economics and masters and doctoral degrees from the University of California, Davis, in economics and in agricultural economics.

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Dr. Zhen Wang is an Associate at The Brattle Group where she focuses on litigation, demand forecasting, and marketing modeling. She has worked closely with utility companies to critically review and develop demand forecasting models. Dr. Wang also works with law firms, government agencies and corporate firms on a variety of legal, regulatory and policy issues. She has performed damages analyses in several high-stake environmental lawsuits and conducted econometric analyses in antitrust/competition related matters. She has also worked on liability determination and damage calculations for commercial arbitrations.

Dr. Wang holds a Ph.D. in Economics from North Carolina State University and a B.S. in Finance from Shanghai Jiao Tong University (Shanghai, China).

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James Hall is a Research Analyst at The Brattle Group where he focuses on utility finance, cost of capital, and demand forecasting.

Mr. Hall holds a B.A. in Economics and Earth & Environmental Sciences from Wesleyan University.

Additional Resources

- Ahmad Faruqui and Eric Shultz, “ Charting the DSM Sales Slump, a Survey of Rate Case Methods for Sales Forecasting”, Fortnightly Spark 2013, <http://spark.fortnightly.com/fortnightly/charting-dsm-sales-slump>
- Ahmad Faruqui, Josephine Duh and Ingrid Rohmund, “Overcoming the Over-Forecasting Bias of Pure Econometric Models: A Utility Case Study”, Electricity Policy, February 2016
- Juan Pablo Carvallo et al., “Load Forecasting in Electric Utility Integrated Resource Planning”, LBNL-1006395, October 2016
- Ahmad Faruqui and Eric Shultz, “Demand growth and the new normal”, Public Utilities Fortnightly, Dec, 2012.
- “Unlocking Energy Efficiency in the U.S. Economy”, McKinsey Global Energy and Materials, July 2009.

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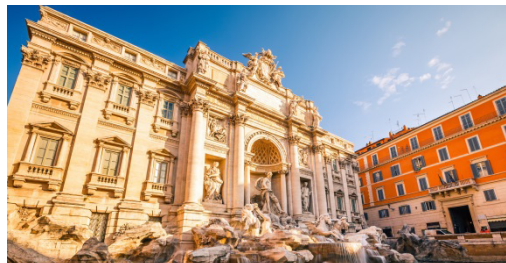
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