DTE ENERGY'S ACCELERATED BILLING ANALYSIS PILOT OF COMMERCIAL & INDUSTRIAL NON-PRESCRIPTIVE PROGRAMS

PRESENTATION TO THE ENERGY WASTE REDUCTION COLLABORATIVE

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Navigant evaluated every Commercial & Industrial (C&I) Non-Prescriptive (NP) project in the 2016 participant database for which hourly or sub-hourly interval meter data was available, using a semi-automated accelerated billing analysis (ABA).

- In 2014, Navigant performed C&I NP Measurement and Verification (M&V) 2.0 research for five projects, comparing 'traditional' on-site evaluation with hourly utility interval data analysis (not automated).
- The 2016 pilot built upon the 2014 findings and recommendations by developing and piloting an automated method for calculating a program-level realization rate (RR) suitable for future regulatory compliance reporting.

M&V 2.0

Automated measurement and verification of energy efficiency (EE) program impacts using hourly or sub-hourly utility interval data for large populations of program participants.

FIGURE 1-1. C&I NP ACCELERATED BILLING ANALYSIS
Tasks and Objectives

	SCOPE OF WORK
1	Automate weather-normalized RR calculations using utility sub-hourly interval data
2	Develop a weather-normalized, statistically significant NP program-average RR based on a review of all 2016 NP participant sites
3	Identify barriers to maximizing the number of projects that could be automatically analyzed in the future
4	Compare the 2016 program verified savings and RR obtained using traditional versus automated methods

Navigant utilized utility-provided data and industry standard sources and methods to develop automated billing analysis (ABA) RR results.

PROGRAM TRACKING DATABASE REVIEW

Reviewed program and customer tracking databases including

- Ex ante utility-reported savings
- Measure types
- Building types

ACCELERATED BILLING ANALYSIS (ABA)

Automated regression analysis of program impacts using:

- Hourly / sub-hourly utility interval usage data regressed with CDH[1] and HDH[1] derived from NOAA[2] historical weather data, and normalized using TMY3[3] typical weather data
- 288 regressions per site-level energy savings estimate:
  - 144 regressions for baseline and efficient analysis periods (2 x 144 = 288)
  - Regressions covered 6 schedules, defined by time-of-week, and time-of-year
    - Time-of-week defined as either weekday or weekend (2 types of schedule)
    - Time-of-year defined as summer, winter, or shoulder season (3 types of schedule)
  - Regression covered 24 hours (time-of-day)
  - 6 schedules x 24 hours = 144 regressions per analysis period (144 baseline and 144 efficient)

(1) CDH, HDH = cooling or heating degree hours respectively, relative to an assumed building balance point of 65F
(2) NOAA = National Oceanographic and Atmospheric Association
(3) TMY3 = Typical Meteorological Year data from National Renewable Energy Labs (NREL) for Detroit

The normalized model for each time period *t* (e.g., summer weekdays), and each hour *i*, was a standard multi-variate linear regression in two variables, TMY3CDH and TMY3HDH.

The intercept α_{it} represents the electrical base load of the building during each time period, and each hour.

MODEL SPECIFICATION

$$kWh_{it} = \alpha_{it} + \beta_{it}TMY3CDH_{it} + \gamma_{it}TMY3HDH_{it} + \varepsilon_{it}$$

$$i = 1..24$$
$$t = 1..6$$

Navigant automated the ABA and developed a final subset of reliable project level RR estimates, meeting pre-determined confidence conditions.

FIGURE 2-1. C&I NP ACCELERATED BILLING ANALYSIS

ABA Workflow

	STEPS IN THE ABA	DESCRIPTION
1	**Data Cleaning and Quality Control:**	For customer sites with available utility hourly or sub-hourly interval data in both pre and post measure installation timeframes, calculate site-level utility-reported savings from program tracking data.
2	**Develop Independent Variable Arrays:**	Process historical (NOAA) and typical (TMY3) outdoor dry bulb temperature, and calculate CDH and HDH for use in model regressions.
3	**Develop Pre and Post Regressions:**	Create hourly pre-measure and post-measure regression models using NOAA-derived CDH and HDH, for summer, winter, shoulder, weekday, and weekend schedules. Normalize pre and post models to TMY3-derived CDH and HDH.
4	**Develop Site kWh Savings and kWh Uncertainty for Every Site:**	For each site, develop the aggregate savings and uncertainty for kWh estimates for both pre and post regressions.
5	**Create 365-day Savings:**	For sites with less than 365 days of automated evaluated savings, extrapolate savings to 365 days and calculate the site level RRs.
6	**Create a Reliable Subset:**	Select a subset of reliable site-level RRs based on pre-determined confidence criteria: **sufficient signal-to-noise ratio, low uncertainty, and exclusivity of NP program**. Use the subset of RRs to calculate the average program level RR and relative precision for NP programs.

The 308 sites found to be reliable represented 14% of sites, and 10% of ex ante reported savings for PY2016.

The primary reason for classifying a site-level RR estimate as unreliable and excluding from further analysis were:

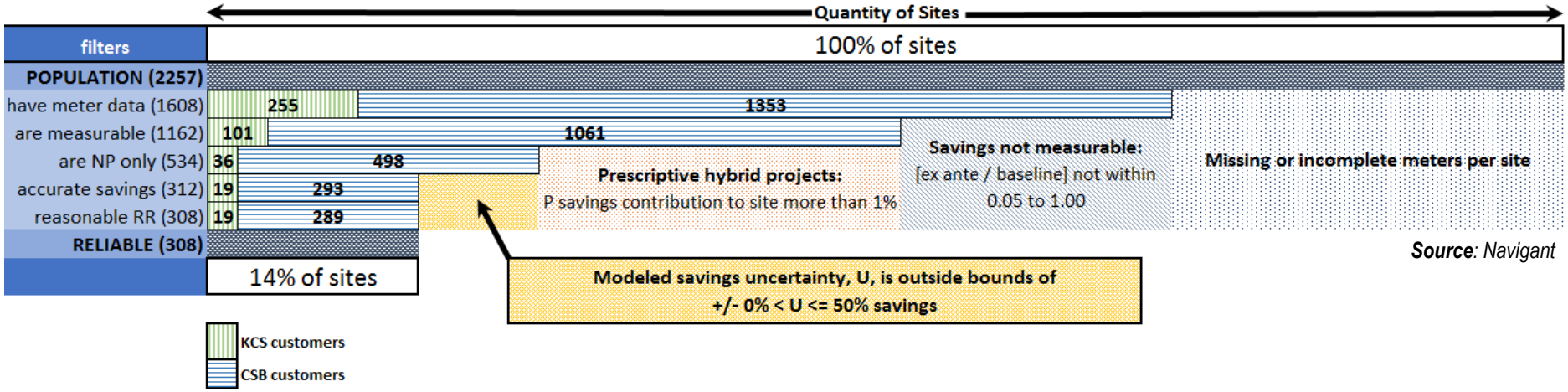
» Low or high savings-to-baseline kWh ("signal-to-noise") ratio (measurability of savings)[1]

» A high percentage of Prescriptive measure savings at the site (non-exclusivity of NP program at site)

» Site-level kWh savings estimates with uncertainty[2] larger than +- 50% (uncertainty in building loads)

FIGURE 2-2: C&I NP ACCELERATED BILLING ANALYSIS

Site Level RR Reliable Subsets for Key Customer System (KCS) and Customer Service & Billing (CSB) customers



***Source**: Navigant*

(1) Selecting the interval between 0.05 (the minimum measurable savings) and 1.00 (the maximum possible savings) ensures the savings are expected to be reasonable, and eliminates a variety of possible data issues and errors, such as possible missing meters per site, poorly mapped meters per site, inadequate baseline usage data, or other data issues not necessarily related to building energy use or savings.

(2) The term 'uncertainty' refers to the site level uncertainty of each site level kWh savings estimate, expressed as a percent (e.g., a site with verified savings of 1,000 kWh +- 100 kWh has an uncertainty of +-10%). This uncertainty is a measure of the expected variability in site-level savings due to a building-level analysis including electric loads unrelated to the efficiency project. Buildings with consistent equipment schedules and electric use (for example, a warehouse with a lighting-dominant electric load) relative to dry bulb outdoor air temperature, may have less uncertainty than buildings with higher variability in electrical loads unexplained by weather variables (for example, a large manufacturing facility with large industrial process electric use).

The ABA pilot resulted in a program level RR of 1.05 with 6.2 percent relative precision, compared with a RR of 1.02 with 6.2 percent relative precision for traditional methods.

» Program level RRs obtained using the two different methods were not statistically different.

FIGURE 3-1: C&I NP ACCELERATED BILLING ANALYSIS

PY2016 Realization Rate (RR) and Verified Gross MWh Savings Comparison: ABA and Traditional Methods

ANALYSIS APPROACH	REALIZATION RATE (RR)	RELATIVE PRECISION OF RR ESTIMATE AT 90% CONFIDENCE LEVEL	TOTAL (PY2016) VERIFIED GROSS SAVINGS (RR x UTILITY REPORTED)	QUANTITY OF RR ESTIMATES
Accelerated billing analysis (ABA) (2016)	1.05 (1)	6.2%	174,187 MWh	308 sites
Traditional 3 year sample (2014, 2015, 2016)	1.02 (2)	6.2% (2)	169,478 MWh (2)	50 projects

***Source**: Navigant analysis*

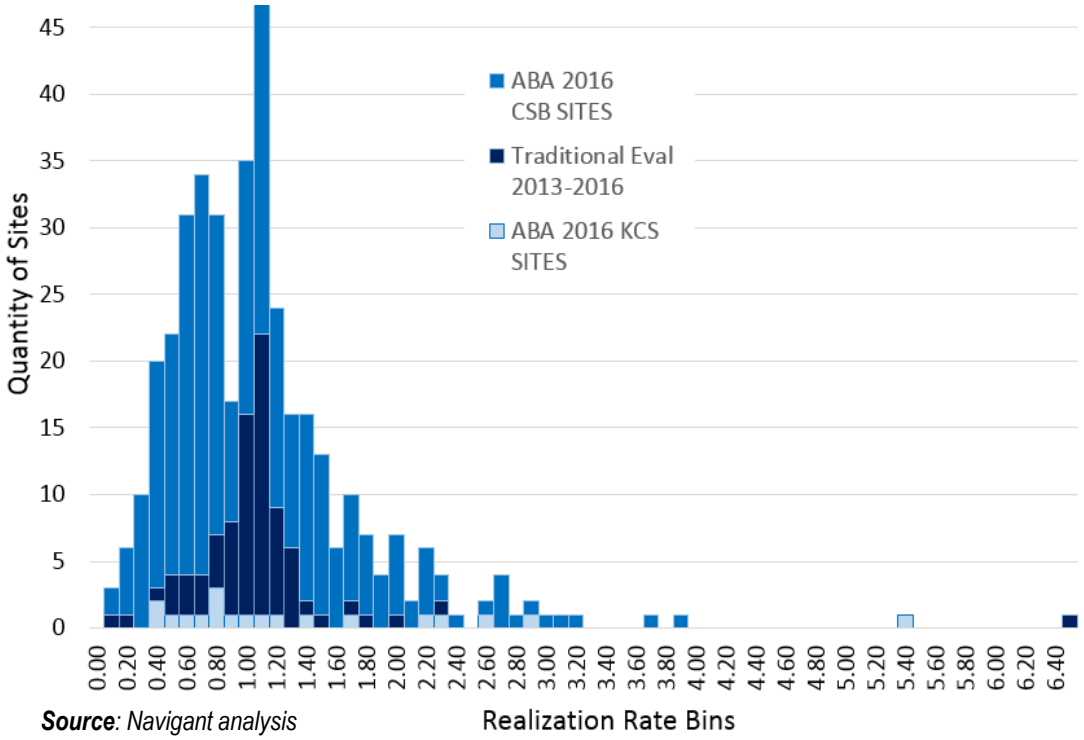
(1) Navigant analysis of DTE Energy (DTE) baseline and efficient hourly interval billing data using ABA, compared with utility-reported savings.
(2) Navigant analysis of DTE project files, Energy Optimization Program Tracker (EOPT) review, and primary data collected from on-site activities, including short duration efficient case datalogging. Values are the same as reported in the DTE 2016 Evaluation Report for C&I Non-Prescriptive Programs.

Navigant found the ABA RR distribution had a wide range of RRs similar to the ranges found in the traditional NP analysis for the last four years.

- The traditional method RRs ranged between 0.02 to 6.43 RR for 2013, 2014, 2015, and 2016. The 308 automation pilot sites used in 2016 ranged from 0.09 to 5.4 RR.
- For the traditional RRs, the range in RRs was found to be due to different hours of operation, and different baseline and efficient fixture quantities and wattages than reported in the ex ante savings calculation.
- For the automated method no definitive information is available regarding the reason for specific realization rates.

FIGURE 3-2: C&I NP REALIZATON RATES HISTOGRAM

ABA and Traditional Methods



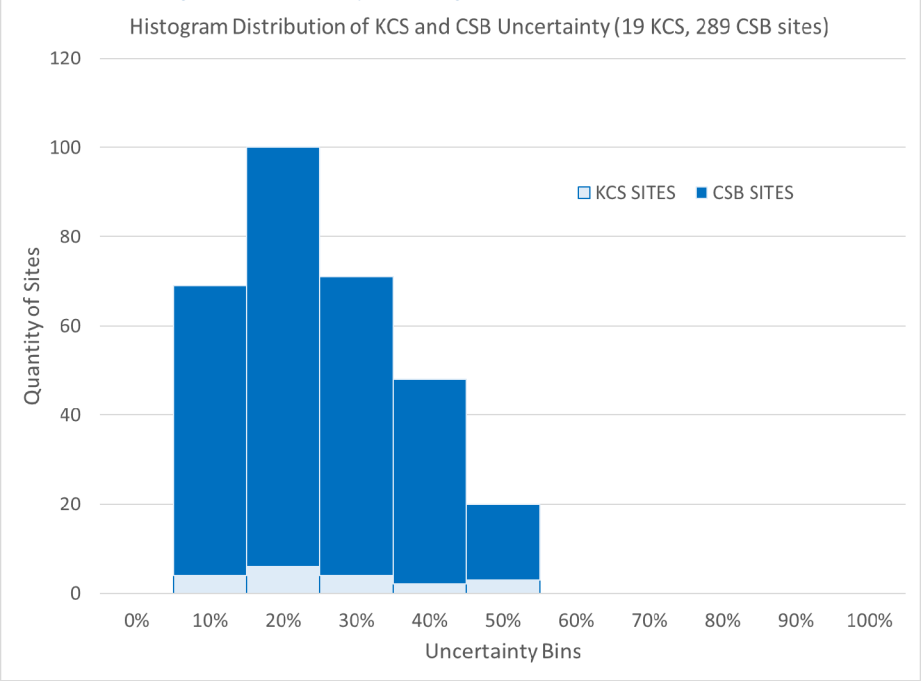
***Source**: Navigant analysis*

The sites included in the ABA pilot had a similar total statistical precision in electric energy use estimates pre and post project completion. This suggests building operation was similar pre and post project, because the energy use precision was similar pre and post.

» The difference between the pre and post aggregate energy precisions(1) relative to building verified savings was +/- 20% on average for 308 buildings. The +/-20% is not a 'propagation of errors' calculation, it indicates a low difference between pre and post building energy use variability.

FIGURE 3-3: C&I NP ACCELERATED BILLING ANALYSIS

Savings Uncertainty Histogram for 308 Reliable Sites



***Source**: Navigant analysis*

(1) Aggregate precisions means that the energy (kWh) precisions for all 144 regressions, were summed for each building, for each of the baseline and efficient case. The difference of these total aggregate energy precisions (baseline aggregate energy precision minus efficient aggregate energy precision) was calculated and divided by the verified savings for the building. For example, an uncertainty of zero means the aggregate energy precision of the efficient kWh estimate was identical to the aggregate energy precision of the baseline kWh for that site.

While a majority of NP program savings were lighting, the ABA method produced reliable results for measures other than lighting.

ADDITIONAL FINDINGS

- Eighty-four percent of NP program savings were lighting savings in PY2016
- 305 of the 308 sites included in the ABA were lighting measures
- Two of the 308 sites included in the ABA were compressed air measures
  - Both compressed air measures had an ABA RR greater than 1 (1.4 and 2.9)
- One of the 308 sites included in the ABA was a process measure at a steel mill
  - The industrial process measure had an ABA RR of 0.7

The ABA pilot provides evidence that automated analysis can result in RRs that are statistically similar to RRs resulting from 'traditional' onsite methods. However, for actionable results supporting continuous improvement some level of site-specific activity is required. Navigant recommends a hybrid approach, integrating the automated results with the traditional evaluation.

FIGURE 4-1: Navigant *Engineered Analytics*
Hybrid EM&V 2.0: Next Generation Evaluation

1 – SCREEN	» Scheduled Meter Analysis Regression Testing (SMART) screening **(early results)**. » **This step alone produced statistically significant evaluated program results in 2016.**
2 – FLAG	» A targeted sample is drawn for sites 'rejected' in the Screen stage. This targeted sample is expected to yield actionable results for more complex sites, using a combination of desk analysis, phone calls, and on-sites.
3 – ANALYZE	» Perform a hybrid analysis combining SMART screening results and results from the more complex, high-improvement-value Flag sample.
4 – REPORT	» The reported evaluation results include a larger number of data points for about the same cost, in a nominally shorter timeframe, with targeted action items for complex projects.

QUESTIONS

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