Beat the Heat with a Better Baseline

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Abstract

Demand Response (DR) performance is evaluated using interval data to develop a baseline using a standard set of parameters that typically includes some type of N-day Average to determine the average shape of the load profile and a true-up period that is used to move the profile up or down to match the actual usage during a specified time period prior to the start of an event. These verification protocols are typically rigidly defined by the entity administrating the DR program and applied to all customers participating in the program regardless of the accuracy of the results.

This paper will examine what happens to these baselines in the real world when extreme electrical emergencies occur or customer's initiate curtailments early or employ strategies that drastically alter their typical load profiles. We will examine the effectiveness of making minor alterations to the existing baseline calculations to develop a custom baseline that more accurately evaluates performance. The custom baseline requires more time and expertise, yet the result is a fairer representation of the demand reduction and energy savings.

It is important for the demand response asset to be fairly evaluated and appropriately compensated for their performance during events. Rigidly applying a pre-defined standard verification protocol, when situations occur as described above, will often result in the participating assets not receiving credit for their full performance. The risk is real that customers that have their performance consistently under estimated will become dissatisfied and drop out of the demand response program to the detriment of us all.

Introduction

During the summer of 2006 the northeastern United States experienced some rather unusual weather patterns that resulted in generally cooler than normal weather with the exception of five extremely hot days. In the five boroughs of New York City, which is referred to as the Zone J load zone by the New York Independent System Operator (NYISO) there were five DR events called for both the Emergency Demand Response Program (EDRP) and the Special Case Resource (SCR) program. Table 1 provides a summary of the dates and times when the 2006 NYISO EDRP and SCR events were called.

2006 EDRP & SCR Program Events								
Date	Day	Zones	Advisory Start Time	Activation Start Time	Advisory Stop Time	Activation Stop Time	Continuation Stop Time	Duration (Hours)
7/18/2006	Tue	H, I, J, K	1:00 PM	1:00 PM	8:00 PM	6:00 PM	10:00 PM	9.0
7/19/2006	Wed	J	1:00 PM	10:35 AM	6:00 PM	7:00 PM	None	9.0
8/1/2006	Tue	J,K		2:00 PM		7:00 PM	None	5.0
8/2/2006	Wed	J,K		1:00 PM		7:00 PM	None	6.0
8/3/2006	Thu	J,K		1:00 PM		7:00 PM	None	6.0
							TOTAL:	**35.0**

Table 1: 2006 EDRP and SCR Program Events

As a result of the extremely hot weather Con Edison experienced several distribution problems and lost feeders serving the northwest sections of Queens starting in mid-July and continuing throughout the summer. Additionally long standing distribution issues were exacerbated by the loss of the feeders and their entire distribution system was at risk. Naturally Con Edison began calling their customers and strongly urged them to “voluntarily” shed load starting around 6:30 AM. News of the Con Ed distribution system troubles spread and the Mayors office began making public appeals and calls to city run facilities to reduce load starting around 9:00 AM. After the initial feeder failures in July, Con Ed was forced to rent trailer mounted diesel generators and place them at various locations throughout the city for several months and the distribution system was in a precarious state throughout the summer.

Given this situation the important question becomes at what time should a customer participating in a NYISO DR program begin to shed load for an event?

A. When Con Ed calls at 6:30 AM?
B. When the Mayor’s Office calls at 9:00 AM?
C. At the NYISO Event Activation Start Time at 1:00 PM?

Our analysis will show that how and when a customer chooses to respond to such appeals has significant effects on their calculated load reductions and payments.

General Discussion of Customer Baseline Calculations

The NYISO DR Verification Protocol for EDRP calculates the Customer Baseline (CBL) which is an hourly estimate of the energy that the customer would have used during an event if no load shedding activities had occurred. The CBL is established by taking the average hourly energy consumption of the five highest of the previous ten weekdays excluding holidays and prior event days. The average hourly consumption is used to create a baseline profile or shape that can then be adjusted up or down using a true-up. The magnitude and the direction of the true-up is determined by the energy consumption that occurs during the two hour period, beginning four hours before the start of the event. True-ups are a valuable tool for adjusting weather sensitive loads to account for changes in ambient temperature between the baseline and event days. This is significant because DR events are typically called on the hottest days of the year and many commercial buildings experience a large increase in electrical consumption due to increased cooling loads. Figure 1 provides a graphical presentation of a baseline calculated using the NYISO protocol with no true-up (on the left) and a True-up from 8AM to 10AM (on the right). Note that the use of the true-up adjusts the CBL up and the resulting fit to the actual load visually appears to be more accurate.

CBL with No True-up	CBL with True-up 8AM-10AM

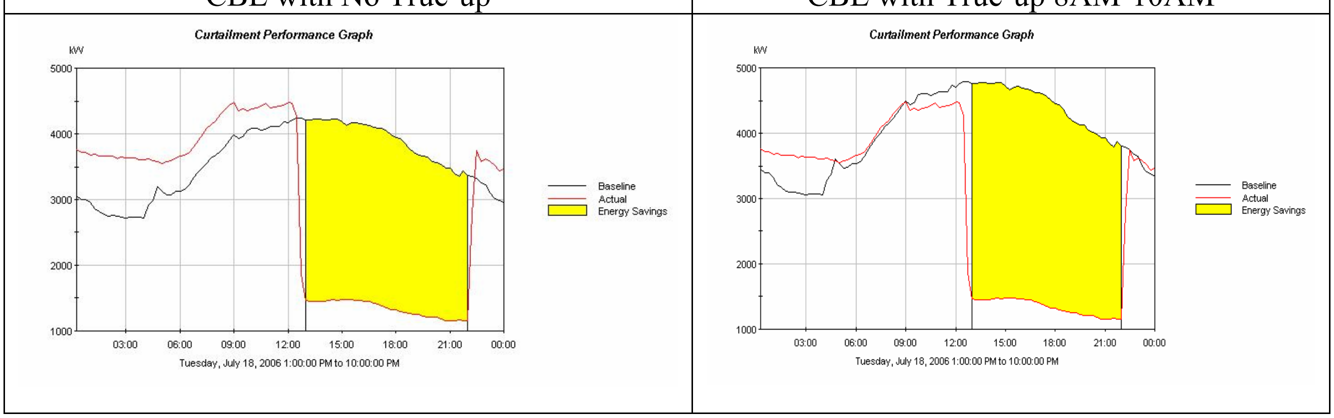

Figure 1: Example of Customer Baseline with and without True-up

Baseline Implications When a Participant Reduces Load Early

The previous example demonstrates what happens in most cases when a true-up is applied to weather sensitive load and the participant facility initiates the load reduction at the official start of the DR event. The resulting CBL provides an improved estimate of demand reduction that is typically higher than the original estimate when no true-up is used.[1] However, what happens when a facility receives multiple outside requests to shed load early and begins to shed load during the true-up period? Figure 2 provides a graphic that shows the load reduction for a large office building during an August 1, 2006 event that officially began at 2:00 PM. As indicated in the figure the NYISO protocol allows for a two hour true-up period that starts four hours before the event, or in this case 10 AM to 12 PM. Note that the facility began to reduce load at 9:45 AM, immediately prior to the true-up period and the load reduction was completed before the end of the true-up. As a result the CBL failed to capture any of the load reduction during the event hours (2:00 PM to 7:00 PM) and therefore the customer would have received no energy payments.

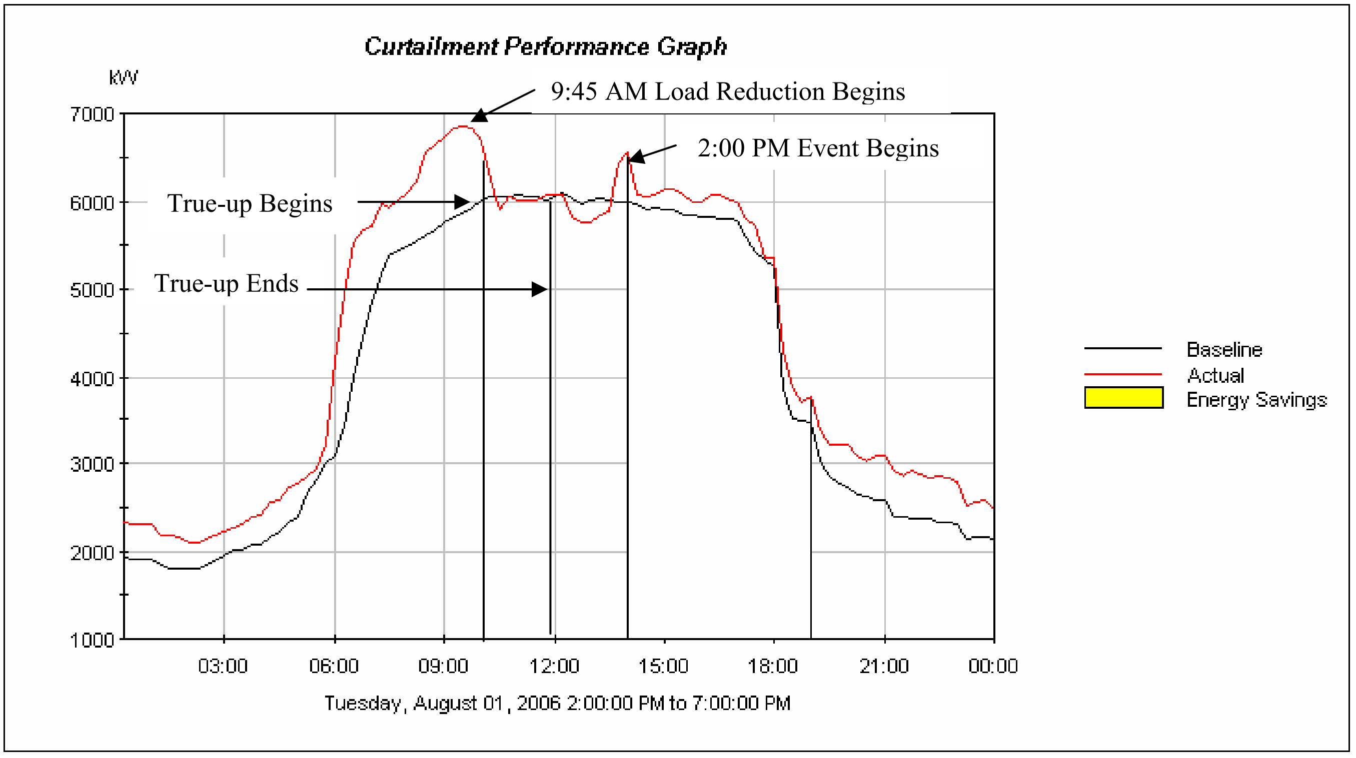

Figure 2: Curtailment Performance Graph Large Office Building with Standard True-up

The NYISO verification protocol allows for a participant to select whether or not they want to have a true-up adjustment applied to their customer baseline. Participants are not allowed to change their selection on an event by event basis and can only change their selection at the end of the season. The true-up is applied by taking the average of the actual demand during a two hour period starting four hours prior to the start of the event and the hourly profile is moved up or down to adjust baseline demand to the actual demand. The NYISO true-up is limited so that the CBL profile will not be shifted more than ± 20% or between 80% and 120% of the original value.

The management of the office building in Figure 2 had selected that their baselines be established using a true-up, and because of this they would receive no payment for their energy reduction as shown in

[1] This is usually true because the ambient temperature during the event is higher than during the previous ten days that are used to create the baseline profile.

the previous example. However what would happen if the CBL was created without a true-up? Figure 3 shows the resulting curtailment performance graph when the CBL for this facility is created without using a true-up. The average load reduction during the event is approximately 361 kW and the total energy savings is 1,803 kWh. The August 1, 2007 event occurred on a day when temperatures at Central Park peaked at around 95° F with high humidity. Analysis of the facility load data indicated that the previous peak at the facility during a non-event day occurred on June 17, 2006 when the facility peaked at 7,084 kW at 1:00 PM. The temperature on June 17th peaked at 87° F with high humidity, but one would reasonably expect that the peak demand during the August 1, 2007 event would be at least as high as occurred on June 17. The CBL created without the true-up has a peak demand of 6,765 kW, 319 kW lower than the peak that occurred on June 17. In order to more fairly evaluate the load reduction we examined the use of a minor baseline modification that adjusted the timing of the true-up period to account for the early start of the load reduction.

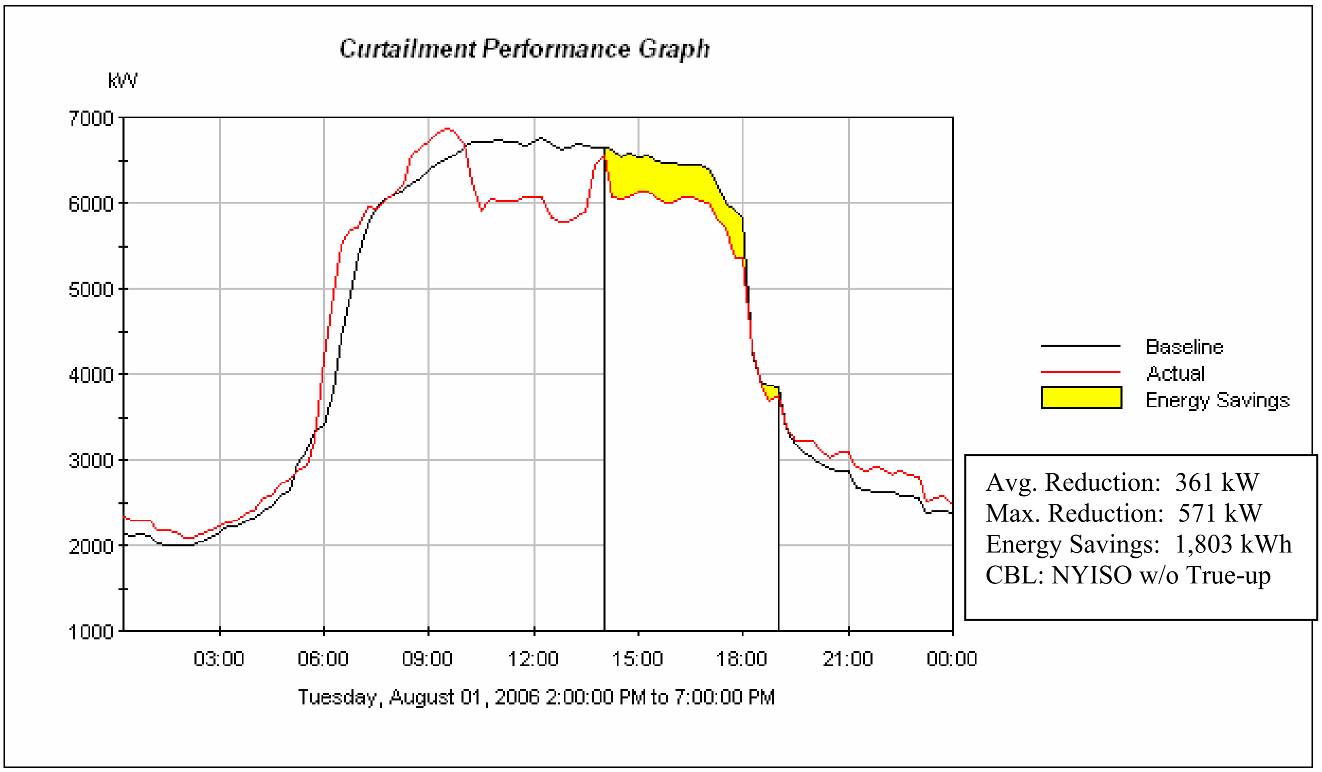

Figure 3: Large Office Building Curtailment Performance with no True-up

Figure 4 shows the curtailment performance graph for the same office facility, where the true-up was modified so that it was applied during the hours from 7AM to 9AM, which is before the facility's load reductions were initiated. In this case the average load reduction was 582 kW and the total energy savings during the event was 2,910 kW. The CBL created with this true-up period has a peak demand of about 7,000 kW, which is still a conservative estimate of the actual peak demand at the facility in the absence of a DR event. Note that the match between the CBL and actual profile is also better during the morning hours starting around 6AM.

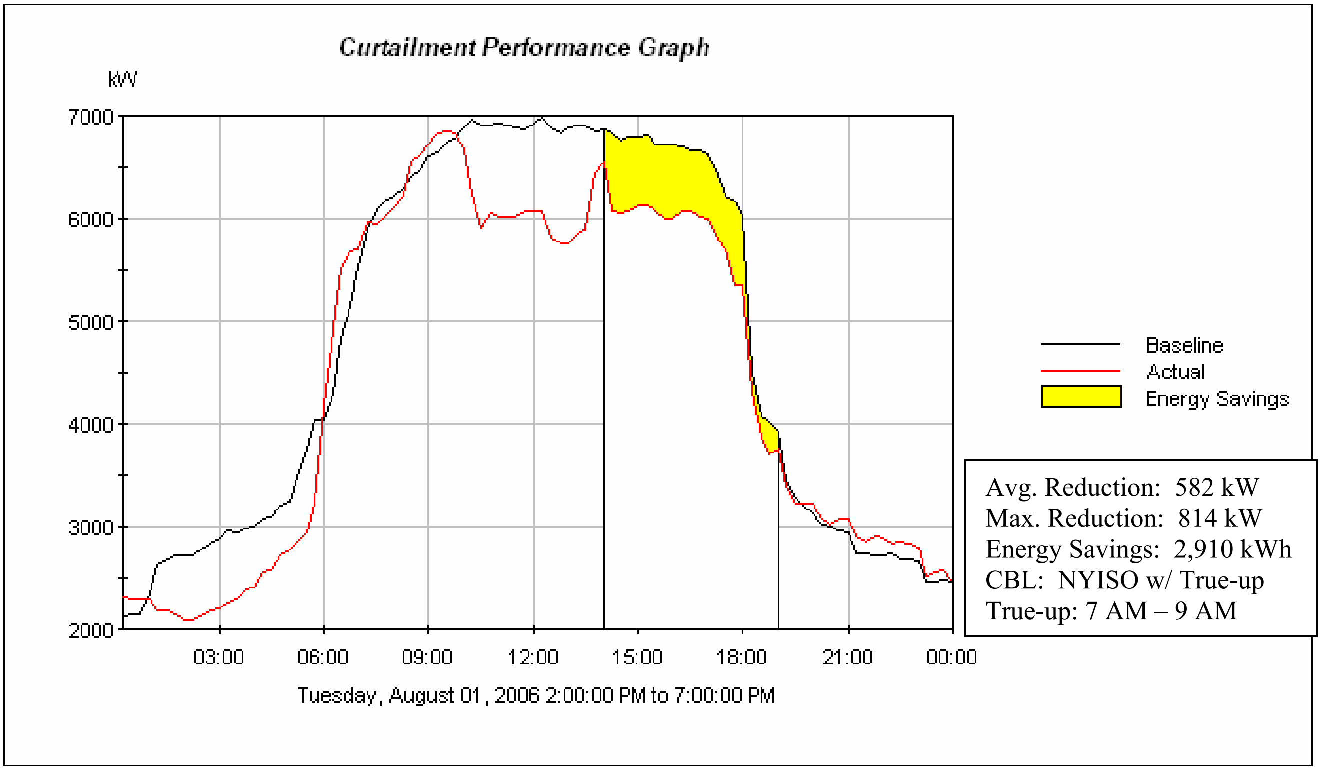

Figure 4: Large Office Building Curtailment Performance with Modified True-up

Table 2 presents a summary of the results of utilizing the three different scenarios to evaluate the demand impacts of the large office facility. Under the first scenario where the NYISO algorithm with a true-up is correctly applied in accordance with the rules of the program, the facility would have no demand reduction and would receive no energy payment. Under the second scenario where the NYISO algorithm with no true-up is used the facility actually receives credit for a 361 kW demand reduction and an energy payment of about $900.[2] Finally under the third scenario, where the true-up time period is changed to 7AM to 9AM the average demand reduction is 582 kW and the customer would receive an energy payment of $1,455 , which is 38% higher than when no true-up was used..

Verification Methods	Avg. Demand Reduction (kW)	Total Energy Savinngs (kWh)	Energy Incentive ($/kWh)	Energy Payment ($)
NYISO w/True-up	0	0	$ 0.50	$ -
NYISO no True-up	361	1803	$ 0.50	$ 901.50
NYISO w/ Modified True-up	582	2910	$ 0.50	$ 1,455.00

Table 2: Summary of Results for Large Office Building

Baseline Implications of Extreme Operating Conditions

The conditions that existed during the summer of 2006 primarily in Queens caused many of the EDRP/SCR participants to drastically alter the way they operate their facilities. One of the more common practices was to employ an extreme pre-cooling strategy during the early morning and over night hours so that the building could operate with little or no cooling during the event hours. Utilizing this type of strategy drastically alters the load profile of the facility during the event day and makes it very difficult to use a

[2] Technically this should not be done because at the beginning of the season the customer specified that they should be evaluated using a true-up.

rigidly applied true-up that is fixed to a specific time period. Figure 5 shows the curtailment performance of a university building on August 3, 2006 (the third day of three consecutive event days). The facility employed an extreme pre-cooling strategy starting at the end of the August 2nd event and as shown in the graph the cooling equipment operated all night to take the heat out of the building and was shut down at 6:00 AM. The EDRP/SCR event officially began at 1:00 PM, which meant that the true-up period was from 9:00 AM to 11:00 AM and results in no load reduction being evaluated for the event. In this case the customer load is actually increasing during the true-up period and at first glance it appears that the true-up is providing an accurate CBL. However by applying the true-up during this period the magnitude of the CBL profile has been reduced by about 12% from the original profile without a true-up.

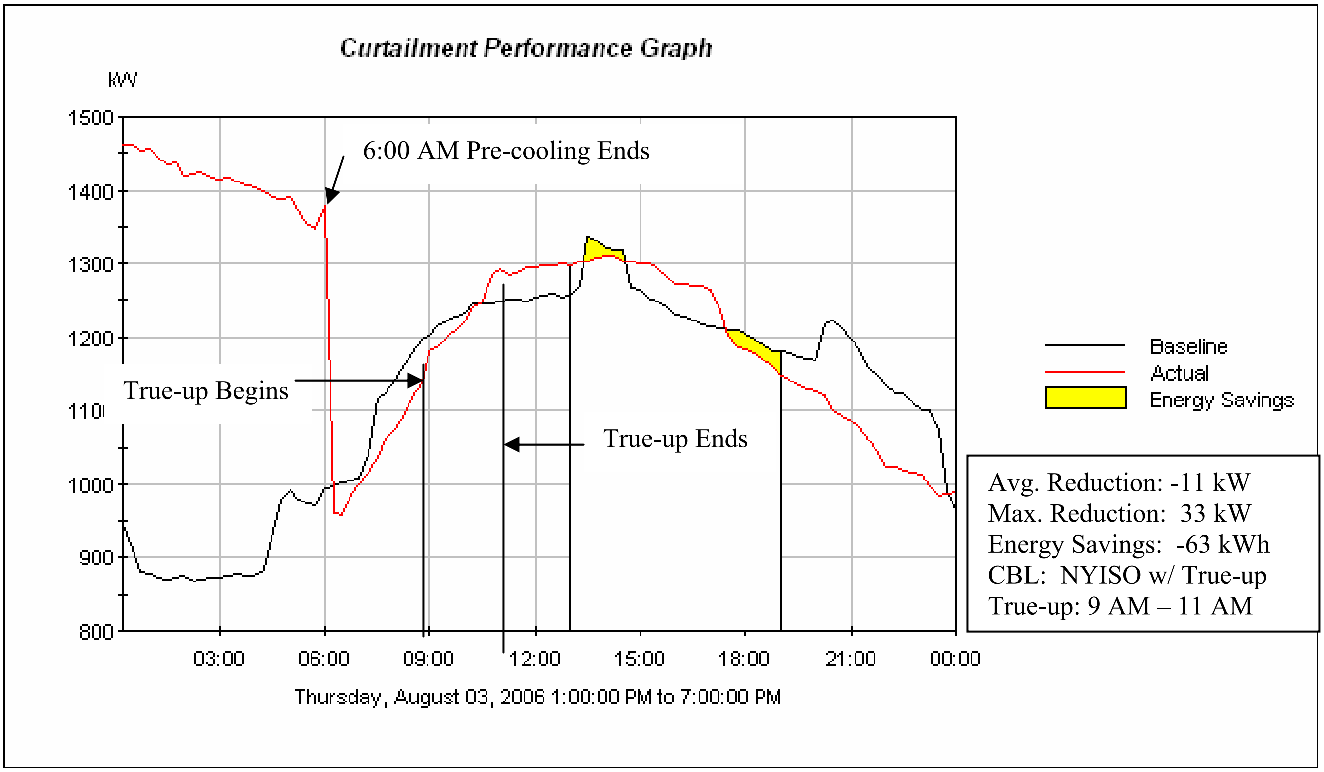

Figure 5: Facility with Extreme Pre-cooling Performance using Standard True-up

Figure 6 shows the curtailment performance graph for the same facility when evaluated using the standard NYISO protocol without using a weather sensitive true-up even though this customer selected to have their demand reduction evaluated using a weather sensitive true-up. In this case their demand reduction would have been evaluated with an average demand reduction of 158 kW and a total energy savings 957 kWh had they selected not to use a true-up. The peak temperature on August 3, 2006 reached 95°F for four hours during the afternoon, the previous peak demand at this facility was 1,748 kW on July 27, 2006 when the temperature reached 87°F. The CBL profile shown in Figure 6 had a peak demand of 1,520 kW, 228 kW lower than the previous peak demand of July 27th. Once again because the building demand is weather sensitive it would be reasonable to assume that the peak demand would be about as high on the event day as it was during the July 27th peak demand day.

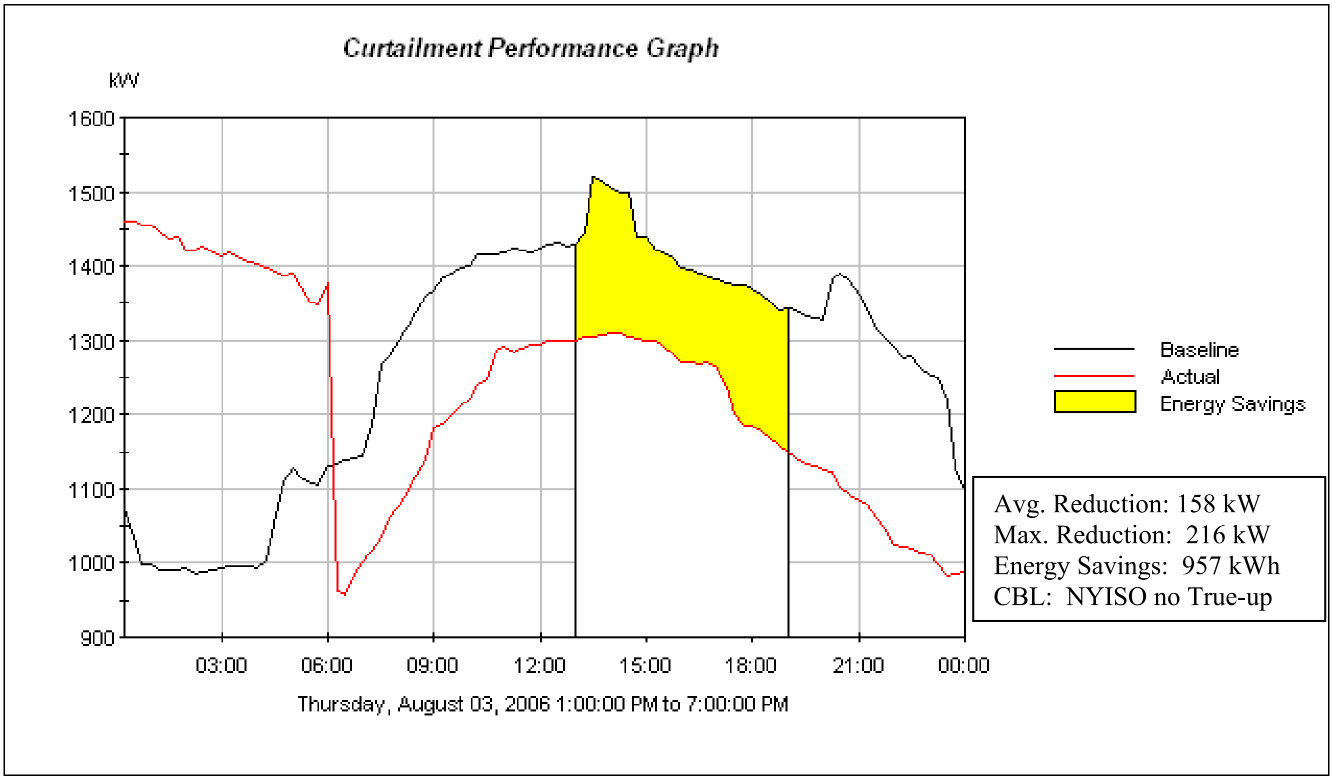

Figure 6: Facility with Extreme Pre-cooling Performance with no True-up

Figure 7 shows the curtailment performance graph for the same facility when the CBL is calculated using a modified true-up period that runs from 5 AM – 7AM. In this case the average demand reduction was 230 kW and the total energy savings was 1,379 kWh. The peak demand of the CBL was 1,589 kW, which is about 6% higher than the peak demand of the CBL that was established using no true-up, but still lower than the previous peak demand of 1,748 kW. In this case the true-up period was selected because it pulled the CBL up to a more accurate level without creating unrealistic results, albeit conservative. Had the true-up period been shifted back one more hour so that it was applied across the hours from 4AM – 6 AM the peak demand of the CBL would have been 1,944 kW, which is too high to be believable. Under these circumstances where the event day profile has an unusually high morning demand caution must be used to make sure that the true-up does not result in a CBL that is too high or too low.

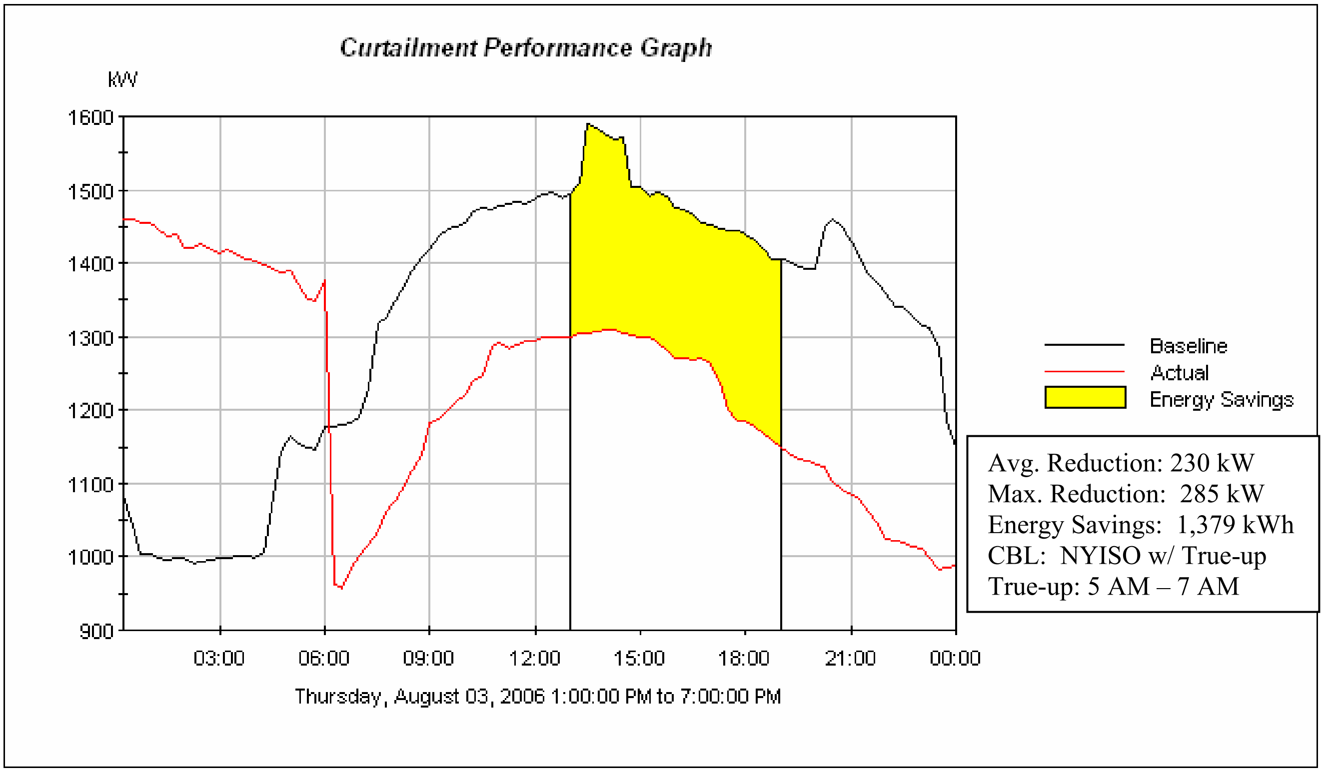

Figure 7: Facility with Extreme Pre-cooling Performance using Modified True-up

Table 3 summarizes the results of the evaluation of the demand response for the university building using the three different verification methods. As was the case in the first example, under the first verification scenario (which is the method that technically should be used) the participant would have no demand reduction and would receive no energy payment. Under the second scenario where the NYISO algorithm with no true-up is used the facility actually receives credit for a 158 kW demand reduction and an energy payment of about $478. Finally under the third scenario, where the true-up time period is changed to 5AM to 7AM the average demand reduction is 230 kW and the customer would receive an energy payment of about $690 , which is 31% higher than when no true-up was used.

Verification Methods	Avg. Demand Reduction (kW)	Total Energy Savinngs (kWh)	Energy Incentive ($/kWh)	Energy Payment ($)
NYISO w/True-up	0	0	$ 0.50	$ -
NYISO no True-up	158	957	$ 0.50	$ 478.50
NYISO w/ Modified True-up	230	1379	$ 0.50	$ 689.50

Table 3: Summary of Results for Building using Extreme Pre-cooling Strategy

Conclusions

The previous examples have explored the implications of using of different verification methods to evaluate the amount of demand response provided by participant facilities under a couple of different commonly encountered scenarios. In both cases if the participant facilities were evaluated in strict accordance with the rules of the DR program their performance during the event would have been zero. However, using data visualization techniques we were able to identify the problem with the original analysis and utilize alternative verification methods that were able to more accurately evaluate the amount of demand response provided.

In general when a true-up is used to develop a customer baseline the results typically are more accurate than a customer baseline with no true-up, because the average profile is adjusted to actual consumption at some time period during the actual event day. However, in our examples the problem with the verification method focused on program participants that had reduced their load too early and as a result were being penalized by having their demand reduction under valued. In these examples baseline profiles without true-ups were also presented and in both cases the amount of demand response evaluated for the event increased over the amount evaluated using the standard true-up, but were lower than when evaluated with a more appropriate true-up time period. The modified true-up periods were used to create baselines that were compared to previous peak demand at the facility to make sure that they were reasonable. In both cases the modified true-up methodology appeared to provide the most accurate results and the energy payments were about 33 % higher than when evaluated using the NYISO verification protocol with no true-up.

The true-up process is based on the premise that there is a relationship between outside temperature and total kW load that can be used to help predict what load will be in the absence of a curtailment signal. This premise is not true when customers initiate new or novel cooling approaches such as pre cooling which destroys this average relationship. The key question is whether administrators should be allowed to use information about emergency cooling strategies to modify the rules or timing of the true-up period.

It is our belief that administrators should use the same CBL method but allow the program administrator the flexibility to decide when to override the timing of the true-up period if the customer is responding to political appeals using new cooling strategies during extreme weather conditions. Program participants would welcome this new discretion knowing that the effort they are putting forth to perform demand reductions is more accurately paying off. They may even do more to reduce loads if they know that they will be compensated fairly.

The important thing to remember is that no verification method is 100% infallible and it is the responsibility and obligation of the Curtailment Service Provider (CSP) to look at the data and make sure that their customers demand response is being evaluated correctly. Demand Response providers typically extend a lot of time and effort to recruit customers into DR programs and participants are their most valuable asset. If the demand response of participants is not evaluated accurately under the default verification protocol than it is the obligation of the CSP to develop a method that is acceptable to the ISO, but also accurately evaluates the demand response. Participants also work very hard and make sacrifices to participate in DR programs and if their efforts are consistently under valued because of issues with the Demand Reduction Verification Protocol they will leave the program.

When facilities reduce load by raising cooling temperatures, turning off lighting, running generators or other strategies, people at the facility know what is going on and management is aware of the fact that the facility is participating in a Demand Reduction program. The last thing that program administrators want to happen is for the management of a participating facility to inquire about the amount of money earned during the last DR event and the answer to be “nothing because they said we didn’t perform.” This paper identifies some ways of increasing the accuracy of the savings methods by giving administrators more flexibility in applying the CBL method.