Case Studies from Industrial Demand Response Audits Integrated with Renewable Energy Assessments

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ABSTRACT

Crisis or near-crisis energy-demand situations have prompted the development of demand response or reduction programs, which lighten the load through permanent demand reduction, load curtailment/shifting, and distributed generation. Efforts like National Grid's (NGRID's) Demand Response Program offer industrial customers a scoping audit to assess the potential for demand reduction. The scoping audit focuses on identifying additional energy-efficiency opportunities as well as the actual demand response measures. Certain regions in NGRID's territory are designated "target areas" – areas that are slated for some level of infrastructure improvement, but due to siting, permitting, and other issues will not be constructed for a period of time. Customers in these target areas are taught how to manage their peak loads to allow time for the infrastructure improvement to be made.

This demand response program is a joint initiative with the Massachusetts Renewable Energy Trust designed to increase the interaction between the utility and the Trust and to integrate renewable energy efforts with the ongoing demand response and energy efficiency efforts. This paper presents the initiatives taken by Northeastern U.S. utilities, government organizations, and end users, to assist demand response programs and promote renewable energy technologies while increasing their competitiveness in the industrial sector. This paper also describes the process adopted for demand response audits and discusses key anecdotal case studies from the industrial sector, which assess the different demand reduction efforts targeted by the programs. These case studies focus on manufacturing facilities and demonstrate applications such as industrial process controls and scheduling, EMS-based load shedding, load shifting, and a wide array of other technologies including those involving renewable energy.

Demand Response Programs

In the northeast region including New York, the cushion between electricity supply and electricity demand is decreasing. This shrinking gap between the grid capacity and electric demand has prompted development of demand response programs. The primary focus of demand response programs is to reduce the load on the electric grid during the peak hours. This paper presents a few case studies from the industrial sector for demand response programs operated by National Grid, New York State Energy Research and Development Authority (NYSERDA), and ISO New England. The various demand response programs operated by the involved parties are described in detail in the following sections.

National Grid's Demand Response Program

National Grid has been offering the special "targeted" summer demand response program to large customers located on specific circuits where the utility is concerned about the peak load

effect on the local reliability of the system and where the utility's plan to expand the system capacity will take at least 2 years to implement. Certain regions in National Grid's territory are designated "target areas" – areas that are slated for some level of infrastructure improvement, but due to citing, permitting, and other issues will not be constructed for a period of time. Customers in these target areas are taught how to manage their peak loads to allow time for the infrastructure improvement to be made. This paper is focused on demand response audits conducted in Everett, Massachusetts – target area for National Grid.

Under the terms of the targeted program, a customer who agrees to shed at least 50 kW during a declared emergency response event will receive capacity payments of $3 per kW per month for June through August and an additional $0.50 per kWh for energy reduced during an event. In addition the customer will be automatically enrolled in ISO New England's price response program. On average National Grid expects between four and twenty emergency event hours per season. Through the demand response program, National Grid offers free demand response audits for customers who indicate their willingness to participate in the program.

The demand response measures are categorized into three measure types – everyday demand response, price-spike demand response, and emergency demand response. The measures under the everyday demand response category could be implemented virtually every day. The price spike demand response measures would be implemented when the wholesale cost of electricity is greater than $0.25 per kWh. The emergency demand response measures would be implemented when the utility declares an emergency and there are chances of brownouts or power outages.

In the state of Massachusetts, investor owned electricity companies likes National Grid are required to collect a "renewable energy" charge of $0.0005 per kWh from their customers. The revenues from the renewable energy charge are used by the Renewable Energy Trust (RET), which is managed by Massachusetts Renewable Energy Trust (MRET), to fund renewable energy projects within the state of Massachusetts. National Grid has been working with the RET for over a year on system capacity issues and has recently executed a grant agreement known as the "Congestion Relief Pilot." This pilot program is only available to the large customers located in a relatively small geographical area within Everett, which has certain constraints on National Grid's distribution system. The pilot program takes load management a step further. Through this pilot program National Grid intends to implement a combination of renewable energy measures, energy-efficiency measures, and demand response measures with controls and communication, including real-time metering. National Grid hopes to determine if this type of combination strategy will allow for improved electric service quality and reliability as well as potentially defer investments to increase the local distribution and transmission systems' capacity.

Currently there are twenty large commercial and industrial customers within the area who have been initially targeted for this pilot project. The RET may use this program, if successful, as a model for future project collaboration with the distributed companies.

Through the joint effort, National Grid offers the following to their large commercial and industrial customers in Everett:

- A comprehensive audit at no cost to the customer by professional engineers who specialize in identifying energy conservation, renewable energy, and demand response opportunities. A detailed study may be conducted to assess the savings potential for the

identified opportunities. In addition, incentives may be awarded for projects that qualify and move forward.

- A special summer targeted demand response program that offers retainer payments of $3 per kW for the summer months and $0.50 per kWh for energy reduced during an event, on top of credits earned through voluntary participation in a program available to all customers in New England by the Independent System Operator.
- Potential incentives to enable automated demand response such as EMS enhancements, if applicable, geared toward a 2-year simple payback.
- A detailed feasibility study resulting in a detailed RFP or vendor proposal, if a renewable energy opportunity is shown to be viable.
- Enhanced incentives toward the installation of renewable energy capacity, such as a solar cell array, that can bring the simple payback down to about 4 years.

NYSERDA's Demand Response Program

The objective of NYSERDA Peak Load Reduction Program (the Program) is to improve electric system reliability and system load factor, as well as reduce electric costs by providing incentives that result in system coincident electric summer peak demand reduction in New York State, particularly in New York City, where there are serious capacity constraints. Incentives are offered to develop and implement peak load reduction project(s) that meet this objective. Measures installed under the program must perform as an integrated function without compromising applicable building code requirements or occupant health, comfort, or safety. The customer baseline load profile and strategy for accomplishing peak load reductions must be clearly delineated in a technical assessment report. This report must be provided by the participant facility or the contractor they are working with on the demand reduction effort. The integrated program consists of four components:

- **Permanent Demand Reduction (PDR)** results in reduced peak demand during the Summer Peak Demand Reduction Period, through the installation of equipment that provides long-term (expected to be in place and operational for at least 5 years), overall system coincident peak demand reduction.
- **Load Curtailment/Shifting (LC/S**) results in reduced peak demand either in response to an electric capacity shortfall or defined price signal. Each participating facility must register in the New York Independent System Operator's (NYISO) Installed Capacity Special Case Resource (ICAP/SCR) program or Real Time Pricing (RTP) program for at least two entire Summer Peak Demand Reduction Periods.
- **Distributed Generation (DG)** results in reduced peak demand by enabling Qualifying Generators in the Con Edison service territory to offload all or a percentage of a facility's electric capacity. This component of the program supports both the installation of new generators and modifications to existing generators. Base loaded generators are ineligible for funding. Generators funded through this program are operated only in response to an event or test called by the NYISO through the ICAP/SCR program.
- **Interval Meters (IM)** result in reduced peak demand through the purchase and installation of interval meters and associated communications equipment. This enables participation in load reduction programs such as the NYISO's Demand Response

programs, and/or an opt-in RTP program for at least two entire Summer Peak Demand Reduction Periods.

The types of incentives available through the NYSERDA Peak Load Reduction Program include a general reimbursement incentive, an aggregation incentive, and a controllable appliance aggregation incentive. The incentive caps applicable to the program are as follows: (a) total incentives per contractor under this Program will not exceed $5 million, (b) total incentives per facility for measures under this Program will not exceed $1 million, and (c) contractor and/or facility caps and program funding may be adjusted based on program activity and funding resources. Program funding will be closely monitored to ensure that the program passes the total resource cost test. Program caps may be adjusted to ensure that the program as a whole passes the total resource cost test, as required by the Public Service Commission.

To be eligible for incentives, facilities must contribute to the System Benefits Charge (SBC) or Con Edison's Monthly Adjustment Clause (MAC) at the time of application and continue paying it throughout the contract term. In the event the customer pays the SBC or Con Edison's MAC on less than 50 percent of the total annual electric consumption (kWh) at the facility, the incentive will be prorated as follows:

Prorated Incentive = (SBC or MAC kWh/Total kWh)*(standard incentive)

Table 1. Reimbursement Incentive Caps

PDR		LC/S		DG	IM
Con Edison Territory	Non-Con Edison Service Territory	Con Edison Territory	Non-Con Edison Service Territory	Con Edison Territory only	Statewide
$600/kW[2] Electric-to-Steam COP[3] > 1.02 $1,000/kW COP[3] <= 1.02 $600/kW	$300/kW[2]	$200/kW	$50/kW	$150/kW	$1,500/meter

Source: NYSERDA Peak Load Reduction Program Opportunity Notice (PON) 1097

The incentive for a project is the lesser of 65 percent of the Eligible Project Costs or the incentive caps set forth in table 1. The facility owner/operator must contribute no less than 35 percent of Eligible Project Costs for all measures funded through this program. Ineligible project costs include facility staff labor or ongoing expenses such as subscription fees, software licensing fees, service/maintenance fees, communications or Internet fees, etc. that might be associated with the project.

No more than 30 percent of the Eligible Project Costs can be used for project development. Project development includes administrative costs, overhead, engineering, marketing, development of the technical assessment report, travel expenses, profit, and other related expenses. Further, no less than 70 percent of the eligible project costs can be used for project implementation, which includes only direct expenses for the purchase and installation (labor and material costs) of equipment at the facility.

ISO New England Demand Response Program

The utility grid power requirements in the southwestern Connecticut region is increasing at a rapid pace. The electrical utilities in the region are experiencing difficulties with the transmission infrastructure and the ability to deliver the required capacity. This becomes

especially problematic during peak load periods. ISO New England is the organization that oversees the power grid in the state of Connecticut. ISO New England has implemented a load reduction program called Cool Sentry. In the past, Cool Sentry has primarily focused on residential and small commercial customers, but large commercial and industrial customers are now encouraged to participate in the program.

During hot summer days when the electric system peaks, ISO New England may call a demand response event to reduce load on the grid in efforts to ensure reliability. Participating customers who have enrolled in the program to provide load reduction would be notified prior to the demand response event and once the event is called would need to reduce the load in the facility. The customer would be compensated on the demonstrated load reduction. The total demand reduction will be monitored by a third-party consultant using special equipment installed through the program.

Case Studies

The following sections outline significant projects that serve as case studies of unique demand response enabling technologies.

Case Study for National Grid: Medical Device Manufacturer

The 55,000 square-foot building was commissioned in 1957 and consists of manufacturing areas and offices. The entire building, including the manufacturing area, is cooled using a central chilled water system with three air-handling units (AHUs). Two water-cooled chillers supply chilled water to the cooling coils in the AHUs, and two #2 natural gas boilers supply hot water to the heating coils in the AHUs. The facility has two new cooling towers equipped with variable frequency drive (VFD) controls for the tower fans. Based on the discussions with the site contact and the observations made during the site visit, the HVAC equipment in the building is more than 40 years old. The facility also houses several clean rooms, which are served by dedicated air-conditioning units. The facility operates 24/7 and has two full shifts and a skeleton-crew third shift.

The following demand response measures were identified during the site visit.

- **Pre-cool and shut-off fans in three AC units.** This measure was categorized as a price spike demand response measure. Based on discussions with the site contact and the information obtained during the site visit, AC-4 (serving the hallway outside SPU and the machine shop across the hall), AC-2 (serving the second floor front office areas), and AC-9 (serving the first floor front office areas) could potentially be switched off for a few hours during a demand response event. The overall operation would involve pre-cooling the target areas to temperatures well below setpoints and then shutting off the selected AC units. The target area temperatures would increase over a longer period of time allowing enough time to switch off the selected AC units during the demand response event. In addition, there would be cooling kW reduction associated with the measure. Based on the information obtained during the site visit, the general office occupies a total area of 5,500 square feet. Assuming that approximately 75 percent of this area would be covered under this measure, the total cooling load reduction for the measure area would

be approximately 12 tons. The chillers are old and hence are assumed to have an efficiency of 1 kW/ton. The total demand reduction potential is estimated to be 20 kW.

- **Operate a generator during an emergency demand response event.** This measure was categorized as an emergency demand response measure. Currently the facility does not have a generator to pick up load in the event of power failure or a demand response event. However, the facility management expressed interest in purchasing a generator to facilitate load reduction during demand response events and during power outages. No formal study has been conducted for the facility to assess the actual generation potential using a bio-diesel generator. For calculations, we assume that the facility would likely consider installing a 100 kW generator. Thus, the total demand reduction from operating the generator during emergency demand response event would be 100 kW.

In addition to the demand response measures, renewable energy opportunities were also assessed at the site. Based on the observations made during the site visit, the facility roof consists of several rooftop HVAC units. However, the central part of the southern side of the roof, approximately 2,500 square feet, is an ideal location for the installation of PV panels. Additional information regarding the integrity of the roof and its ability to withstand additional load was not available during the site visit. Since the building was commissioned in the 1950s, we recommended that the facility management conduct a detailed study to estimate the load bearing capacity of the roof for a successful PV system installation. A total generation capacity of 25.2 kW was estimated at the site.

In addition to the demand response and renewable energy measures, the following energy-efficiency opportunities were identified at the site:

- Install variable frequency drives (VFDs) on chilled water pumps.
- Install VFDs on AHU supply fans.
- Install VFDs on hot-water circulation pumps.
- Use notched V-belts.
- Install air-entraining type vortex blow-gun nozzles.
- Upgrade single-paned windows to double-paned windows.
- Upgrade to Super T8 fluorescent lighting fixtures.
- Install lighting controls for office lighting.
- Upgrade the existing chiller plant.

Case Study for ISO New England: Powdered Metal Parts Manufacturer

The company manufactures small intricate powdered metal parts. Approximately 40 percent of the company's business comes from the medical sector while the remaining comes from a combination of industries, the most prominent being automotive and circuit breakers (electrical). The facility is more than 15 years old and occupies approximately 15,500 square feet of area housing both the office space and manufacturing areas. With the exception of the furnace room, the entire facility is space conditioned using one 20-ton and two 15-ton rooftop units.

The facility has a Johnson Metasys system that provides control for the existing rooftop air-conditioning units. No additional equipment is controlled through this system.

The facility operates twenty-four hours per day, Monday through Thursday. The facility contains a total of forty presses ranging from a 1/2 ton to 50 tons. Based on discussions with the maintenance personnel, at any given time, approximately 70 percent of the presses are in operation. The heat treating furnaces in the facility are gas fired. A 25-hp rotary-screw Ingersoll Rand air compressor provides compressed air to the facility at 120 psi. Compressed air is primarily used in the facility for pneumatic actuation. The site contact indicated that the lighting in the facility was upgraded to efficient fluorescent technologies approximately 2 years ago.

Based on the billing information obtained during the site visit, the average annual electric consumption was estimated to be approximately 450,000 kWh per year with an average monthly demand of approximately 95 kW. The billing history indicates facility demand is high during summer months, which is attributed to the increase in cooling loads. In 2006, the peak demand was set in August at 134.6 kW. It should also be noted that the utility system peaked in August, 2006 forcing ISO New England to call demand response events on the first and second day of the month. Based on the billing information obtained during the site visit, the blended electric cost for the facility is $0.14 per kWh.

Based on observations made during the site visit and from discussions with the facility staff, two distinct demand response approaches were identified. These approaches provide the facility management with two cost options.

Approach 1: Curtail production activities and control HVAC units. The facility operates twenty-four hours per day, four days per week, Monday through Thursday. The facility staff indicated that during a demand response event it would be feasible to shift the production operations to off-peak hours. In addition, the staff indicated that other maintenance and administrative tasks could be conducted during the event that would result in curtailment of the production activities and related equipment. Such other activities, as suggested by the facility staff, include painting the facility walls, washing the floors, and other facility tasks. During these activities, most of the facility lighting would be on along with a small percentage of space conditioning.

In addition to curtailing the production activities, the facility could also curtail the HVAC load. They would install a superswitch (DCU), which is a radio controlled device that has the ability to send a signal via a relay to the air conditioners. A third-party consultant could remotely communicate with the DCU and through the DCU have the capability to switch the air conditioners from normal operation to load control mode.

Taking into consideration all these factors, the approximate demand reduction was estimated to be approximately 100 kW.

Approach 2: Install and operate a generator. The facility management is currently investigating purchasing a backup generator for emergency situations, which could also serve to operate during a demand response event to reduce the facility load on the electric grid. Based on the billing history, the maximum demand for the facility was set in August last year and was likely coincident with the utility system peak. In 2006, the facility peak demand was 134.6 kW.

This approach involves buying a generator to take care of the entire facility load. This alternative will ensure smooth operation of the facility without any interruption in the production schedule. Additionally, this approach would provide the facility with backup power during non-planned power outages from the utility.

The demand reduction from implementing this alternative was estimated to be approximately 130 kW.

In addition to the demand response measures, the following energy-efficiency measures were identified at the site:

- Upgrade the existing rooftop units with high-efficiency units.
- Replace existing standard V-belts with notched V-belts.
- Install occupancy and daylight sensors in office areas.
- Install VFDs on RTU fans and MAU fans.
- Replace standard motors with premium efficiency motors.
- Reduce compressed-air system pressure.

Case Study for NYSERDA: Food Processing Plant

The production facility is located in a two-story 80,000 square foot building and operates 24 hours per day, 5 1/2 days per week (Sunday through Friday afternoon). Over the past 12 months the site consumed 5,550,000 kWh with a peak summer demand of 1311 kW. The plant has installed a new 550 kW Taylor Power Systems diesel-fired generator and the appropriate controls and electrical equipment to operate both this new generator and the existing 1250 kW Cummins diesel-fired generator simultaneously to meet the facility load and operate in accordance with the NYISO ICAP/SCR demand response program. The facility plans to register 1,300 kW for the Summer Demand Period. Before the implementation of the distributed resources (DR) generators, the site did not participate in the NYISO ICAP/SCR program and contained no onsite generation. An automatic transfer switch was installed for the new 550 kW generator. Additionally, all necessary interconnection equipment was installed to integrate the existing 1,250 kW generator into the system.

Two transfer switches enable the entire building load to be switched from the ConEdison main electrical feed to the load curtailment generators. A small light indicates when the generator is switched on and available to carry the building load. A second small light turns on when the building load has been transferred from the incoming electrical feed to the generator. To switch the load, the operator simply presses and holds a button for 15 seconds.

A load transfer test was conducted transferring the entire building load from the electric grid to the generators. Metered data was captured during this test, which indicated that the overall electrical demand on the grid reduced to zero.

References

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