Impact Evaluation of 2005 Custom Process Installations

Part III

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Prepared for:

National Grid USA Service Company

Prepared by:

GDS Associates, Inc.
Engineers and Consultants

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Executive Summary

Introduction

Purpose of study

The purpose of this study was to evaluate the energy savings achieved by six Custom process measures installed in 2005. The scope of this study was to provide annual energy savings, summer and winter peak diversified demand impact, and percent of energy savings that occur on-peak for each application. National Grid USA Service Company (National Grid, or the Company) contracted with GDS to evaluate the savings of six of the fifteen Custom process applications that were part of the study. Five of the selected projects are in Massachusetts; one project is in Rhode Island.

Description of Evaluation Methodology

Due to the unique nature of the custom process applications being evaluated, GDS developed a site-specific evaluation plan for each project. Most sites received on-site true power (kW) metering for two weeks or more. Spot measurements were deemed sufficient at one site and no measurements were justified at one site.

Prior to contacting the site, GDS reviewed the application package, prepared a preliminary evaluation plan, and submitted the preliminary plan to the National Grid Study Manager.

In most cases, National Grid made the initial contact with the customer. After being introduced by the National Grid contact, GDS telephoned the customer to set up a site visit. During the initial telephone call, GDS typically makes a few inquiries of the customer to better understand the application, to prepare for the site interview, to determine the availability of a site electrician and to refine the evaluation plan. Upon scheduling a site visit, GDS informs the Study Manager, who often arranges to attend the site visits.

GDS visited all six sites included in this evaluation and observed the installed measures in operation. At the site, GDS verified the installed equipment and operating conditions, such as motor speed, production rate, and operating hours. To the extent feasible, we also verify the pre-retrofit or baseline conditions. In most cases, we install metering equipment to monitor power consumption over two weeks or more. For weather-sensitive measures, we also collect relevant weather data.

After the first site visit, we typically discuss the project and our proposed method for calculating savings with the National Grid study manager. It is not unusual to revise the proposed calculation methodology based upon information gathered at the first site visit. In one case information gathered at the first site visit prompted a review of the classification of the project and an ultimate decision to revise the base case and change the application from Energy Initiative to Design 2000*plus*.

Based on the data provided in the application and the first site visit, we make a preliminary estimate of annual energy savings, summer and winter peak diversified kW and percent of energy savings occurring on-peak corresponding to the new peak definitions.

The new peak definitions are:

- On-peak: 6 am – 10 pm Weekdays excluding 9 holidays.
- Summer: Warmest weekday between 3 pm-5 pm in June, July or August
- Winter: Coldest weekday between 6 pm – 7 pm in January

In most cases, a second site visit is required to retrieve the metering equipment. In two weather-dependent projects, the first site visits were conducted in late summer and additional site visits were conducted in winter to collect cold weather data. Upon collection of all relevant data, we prepare a draft site report. In addition to updating the results based on long-term metering data, the final site report also differs from the preliminary estimate in that we determine and report the three on-peak evaluation parameters according to both the new definitions listed above, and the old definitions.

The old peak definitions are:

- On-peak: 8 am – 9 pm Weekdays excluding 9 holidays.
- Summer weekdays: weighted average of savings from 11 am – 3 pm in June, July, August, and September
- Winter weekdays: weighted average of savings from 5 pm – 7 pm in December, January, and February

Description of Sample Projects

Table ES - 1 lists the one-line project description along with application and site number for the projects included in this study. Of the six projects in this evaluation sample, three were predominantly VFD measures. Sites 2, 4, and 6 installed VFDs on various pieces of process equipment. Site 2 installed VFDs on the aeration blowers in a wastewater treatment facility. Site 4 installed a VFD in place of an eddy-current clutch at a mill. Site 6 MRW installed a VFD on a makeup-air unit in a woodworking shop. Site 1 also included VFDs, but was primarily a refrigeration measure which incorporated VFD controlled equipment.

Site 3 installed a heat-of-compression dryer on a new air compressor.

Site 5 included two measures in a supermarket: (1) installing electronically-commutated motors on evaporator fans in walk-in coolers, and (2) installing controls to modulate the power to freezer door heater as a function of humidity in the store.

Table ES - 1

Site	Application	Measure description
1	504480	Refrigerated warehouse with oversized condenser, floating head pressure, and demand-based hot-gas defrost
2	215481	Aeration Blowers VFDs
3	502760	Heat of Compression Dryer
4	506916	Replacement of existing eddy current clutch drives with VFD for Mill Drive
5	506167	Install high efficiency evaporator fan motor and anti sweat control
6	510076	Install VFD control of spray booth makeup air fans

Results

Evaluated annual energy savings varied from 64% (Site 5) to 439% (Site 3) of the tracking estimate. Tables ES-2 and ES-3 list the evaluation results and the tracking estimates for each application studied.

Tabular Presentation of Results

Table ES - 2: Custom Process Projects - Summary of Results (New Peak Definitions)

Site No.	Application No.	Measure Description	Tracking Estimates kWh	% Onpeak	Summer	Winter	Evaluation Estimates - New Defintion kWh	% On-peak	Summer	Winter	Ratio Evaluated / Tracking kWh	% On-peak	Summer	Winter
1	504480	Refrigerated warehouse with oversized condenser, floating head pressure, and demand-based hot-gas defrost	1,130,036	40.0%	105.0	168.2	757,664	46.5%	146.5	88.9	67%	116%	140%	53%
2	215481	Aeration Blowers VSD's	228,404	30.0%	16.5	24.9	253,784	45.3%	23.4	31.2	111%	151%	142%	126%
3	502760	Heat of Compression Dryer	53,925	40.0%	6.3	6.3	236,467	50.0%	29.6	29.6	439%	125%	469%	469%
4	506916	Replacement of existing eddy current clutch drives with variable speed drive for Mill Drive	44,558	82.0%	11.1	11.1	46,253	66.7%	8.6	9.3	104%	81%	77%	84%
5	506167	Install high efficiency evaporator fan motor and anti sweat control	67,170	36.0%	4.0	4.0	76,890	48.6%	9.1	10.2	114%	135%	226%	252%
6	510076	Install VFD control of spray booth makeup air fans	12,865	76.0%	2.6	0.0	8,271	85.5%	0.9	3.9	64%	113%	35%	-

Table ES - 3: Custom Process Projects – Summary of Results (Old Peak Definitions)

Site No.	Application No.	Measure Description	Tracking Estimates kWh	% Onpeak	Summer	Winter	Evaluation Estimates - Old Defintion kWh	% On-peak	Summer	Winter	Ratio Evaluated / Tracking kWh	% On-peak	Summer	Winter
1	504480	Refrigerated warehouse with oversized condenser, floating head pressure, and demand-based hot-gas defrost	1,130,036	40%	105.0	168.2	757,664	38%	146.5	85.2	67%	95%	140%	51%
2	215481	Aeration Blowers VSD's	228,404	30%	16.5	24.9	253,784	37%	22.3	31.1	111%	123%	136%	125%
3	502760	Heat of Compression Dryer	53,925	40%	6.3	6.3	236,467	41%	29.6	29.6	439%	102%	469%	469%
4	506916	Replacement of existing eddy current clutch drives with variable speed drive for Mill Drive	44,558	82%	11.1	11.1	46,253	58%	8.8	8.9	104%	71%	79%	80%
5	506167	Install high efficiency evaporator fan motor and anti sweat control	67,170	36%	4.0	4.0	76,890	39%	9.1	10.2	114%	109%	226%	252%
6	510076	Install VFD control of spray booth makeup air fans	12,865	76%	2.6	-	8,271	71%	1.6	2.9	64%	94%	60%	-

Reasons for Discrepancies Between the Tracking Estimates and Evaluated Results

There are a wide variety of reasons for the deviation between the tracking estimate and the evaluation results. While we present the tracking and evaluated savings estimates for seven quantities, this table focuses on the annual energy savings to understand the primary reasons for the discrepancies. Table ES-4 lists the primary reasons for the discrepancies in energy savings (kWh/yr) estimates which fall into the following categories:

a. Load or hours of operation changed since the development of the tracking estimate: Sites 4 and 6
b. Load or hours of operation have not changed but were different than expected: Sites 1 and 5
c. Evaluation used different machine performance than TA: Sites 1 and 2
d. Mathematical or transcription error: Sites 1, 2, and 5
e. The evaluation determined a different base case: Sites 3 and 6
f. The evaluation included interactive effects neglected in the tracking estimate: Site 5
g. Installed equipment differed from proposed: Sites 1 and 5 (different quantity)
h. Evaluation included savings from components which were neglected by the tracking estimate: Sites 1 and 5

Table ES - 4: Summary of Annual Energy Savings Discrepancies

Site	Application	Eval/ Track	Primary Reason for Discrepancy of Savings Estimates	Reasons #
1	Application 504480 Refrigerated warehouse with oversized condenser, floating head pressure, and demand-based hot-gas defrost	67%	The system was installed and is operating as expected. The primary reasons for lower savings come from mathematical modeling, rounding, and transcription errors on both the base and proposed equipment. . Partially offsetting these reductions, the savings increased due to measures which were included in the MRD but was not included in the TA calculations. This savings also increased due to higher loading than expected. On the hottest days some of the refrigeration equipment has trouble keeping up with the load.	b, c, d, g, h
2	Application 215481 Aeration Blowers VFDs	111%	The evaluation determined that the blowers operate at higher pressures than expected. Equipment performance determined by the evaluation was different than that used by the TA. A transcription error led the TA to overstate air flow.	c, d
3	Application 502760 Heat of Compression Dryer	439%	This application was submitted under Energy Initiative. During the course of this evaluation, the Company determined that this project was more properly considered Design 2000*Plus*. If the project had kept the original base case, the realization ratio would have been 91% with the difference solely from uptime.	e
4	Application 506916 Replacement of existing eddy current clutch drives with VFD for Mill Drive	104%	This project saved about as much energy as expected. The savings increased due to an increase in operating hours - the equipment is operating 2.5 to 3 shifts rather than two as was expected by the TA. Largely offsetting the increase in savings, the evaluation found that the load was lower than expected. Since this VFD project replaces an old ASD with a new, more efficient VFD, lower loads result in lower savings.	a
5	Application 506167 Install high efficiency evaporator fan motor and anti sweat control	115%	This application included two energy conservation measures. In an apparent transcription error, the energy savings of the smaller ECM was omitted from the tracking estimate of savings. The evaluation also included interactive effects neglected in the tracking estimate. Offsetting these gains somewhat, the evaluation also found that the door heaters drew less power than expected and that controls were installed on fewer door heaters than expected.	b, d, f, g, h
6	Application 510076 Install VFD control of spray booth makeup air fans	64%	The evaluation found that these fans operate both more hours and higher loads than expected. In fact, these fans operate at 66 Hz most of the time that they are on. Since the fans are operating above 60 Hz, we had to construct a hypothetical base case. The savings are highly dependent on revised base case design assumptions. We assume a modest amount of over-design in our calculation. An assumption of no over-design would reduce the evaluated savings to about 2% of the tracking estimate.	a, e

Conclusions and Recommendations

Existing Monitoring Equipment

Four of the six applications reviewed had customer-installed permanent monitoring equipment which assisted in the evaluation effort. The two sites with the greatest tracking savings, Sites 1 and 2, had computerized control and monitoring systems. The next two sites in terms of tracking savings, Site 3 and Site 5, had runtime meters. Only the two sites with the lowest projected savings, Sites 4 and Site 6, had no pre-installed monitoring equipment.

The refrigeration computer at Site 1 was installed as part of the project, and its inclusion in the MRD assisted the evaluators in acquiring data from the site's refrigeration contractor. The SCADA system for Site 2 was pre-existing, but additional monitoring for these blowers was included in the National Grid project.

At both Site 1 and Site 2 we had difficulty extracting the data from the system for off-line analysis. At Site 1, local data storage was minimal and customer personnel had no provisions for extracting or printing data on-site. The only access to the system was by modem, whether on-site or remote. Due to limited on-site storage, weekly downloads were required to collect hourly data. Thus, the evaluators were dependent on the good graces of the refrigeration contractor for long-term metering.

Site 2 had 6 months of data stored on-site, and could chart any variable for any desired length of time. However, site personnel did not know how to extract data from the SCADA system to separate files for analysis. The evaluator worked with site personnel and with some effort, learned how to extract data from the system.

Data accuracy can also be an issue. For each site which had their own meters, we confirmed checked power measurements recorded by the site computer with power measurements by evaluator's meters. We had mixed results in this effort; at Site 2 we were able to confirm power measurement reliably, but at Site 1, we were unable to confirm the power measurements and chose to use our own measurements exclusively.

We recommend that site-installed power metering be corroborated with calibrated temporary meters.

Error Checking

A surprising number of sites had transcription errors in calculation or reporting. In several cases the errors were minor and under-estimated savings. However, in the case of Site 1, several seemingly minor errors lead to significant over-estimation of savings. In a complex and detailed analysis such as that one, such errors are difficult to detect, as evidenced by the fact that these errors were not uncovered through the peer review process.

To increase the likelihood of exposing such errors, we recommend that the peer reviewer describe how the project saves energy, including quantification of how much savings come from each energy-saving component. In particularly complex projects, a sensitivity analysis might be in order.

VFD Efficiency

In most energy saving VFD projects, the efficiency of the VFD has a minor impact on the savings. However, VFD efficiency was an important component of two projects in this evaluation sample. This indicates a need for more thorough research into VFD efficiency and/or burden.

Variation in Loading

It is natural to expect some variation in loading as market cycles wax and wane. In this evaluation sample all of the sites which had a variation in operation from what was expected had <u>higher</u> loads than expected. It is reasonable to expect that in other years the hours of operation and loading may be lower than it is now. National Grid may want to consider the natural up and down of business market cycles in long-term energy savings claims.

Uncertainty

The evaluation process works to provide a single set of numbers which characterize the energy and demand savings. However, there is uncertainty about each of these sites, some more than others. In all cases there is uncertainty about the future (as discussed in "Variation in Loading" above). In some cases there is also uncertainty as to the base case. In the case of Site 6, the savings uncertainty ranges from the reported 64% to negative depending on one's assumption about base case selection. In Site 3, a decision to change the base case lead to 439% savings, whereas using the TA-identified base case would result in about 90% of the expected savings. National Grid may wish to incorporate some statistical representations of uncertainty in future results.

Complexity

The evaluation budget and schedule is predicated on an expected level of complexity. From our experience, one in every 6 to 10 projects is much more complex or time-consuming than expected. In this evaluation sample, Site 1 was far more demanding than expected. It drove the budget and delayed the schedule by six to 8 weeks. Technical complexity can be somewhat expected based on the type of measure. However, the availability of information and the time spent acquiring, discussing, and analyzing this information (such as from manufacturers, contractors, and service people) is difficult to foresee. We recommend that National Grid and its evaluation contractors establish a checkpoint to identify when a project is more complex than anticipated with a decision to either undergo separate additional study or to make simplifying assumptions to allow the project to be completed within the budget and schedule.