UTS Energy Engineering LLC

Final Report for

National Grid USA Service Company

Impact Evaluation of

2005 Custom Process Installations—Part II

June 19, 2007

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Supplementary data follows each site report.

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SECTION 1. EXECUTIVE SUMMARY

1.1 Introduction

National Grid provides technical and financial assistance to their commercial and industrial customers for equipment and building energy efficiency improvements. Improvements can be either custom-engineered or selected from a list of prescribed measures. This impact evaluation study is Part II of three parts, and reviews three Custom process projects that fall into two categories: process and non-HVAC VFDs.

The three projects included the installation of an all electric plastic injection molding machine, an industrial heat treatment oven and four VFDs on a water treatment plant's pumps.

1.2 Purpose of Study

National Grid seeks to quantify the actual energy and demand savings attributable to these Custom process projects in order to:

- More accurately determine energy and demand savings achieved
- Demonstrate cost-effectiveness to regulators and other interested parties
- Set appropriate financial incentive levels and eligibility criteria for future years

1.3 Scope

UTS Energy Engineering, LLC (UTS) was commissioned by National Grid to evaluate three Custom industrial process projects installed in 2005. The specific goal of this study was to confirm the annual energy savings (kWh per year), the percent of energy savings that occurs on-peak, and the summer and winter peak coincident demand savings (kW) attributable to the projects at each site. National Grid has recently changed the definitions of when seasonal peak demands occur and the hours that they define as on-peak. For this year, the goals of the study also included determining peak demand and energy savings using these new definitions.

Two of the evaluated projects were Design 2000*plus* (D2) projects and the other an Energy Initiative (EI) project. The Design 2000*plus* program is meant for new construction or new systems and for old systems that are being replaced and redesigned to meet new conditions, where the base case is not the pre-existing system, but one that is designed to meet the anticipated load. Energy Initiative projects are installed on existing systems for the sole purpose of saving energy.

1.4 Survey and Analysis Methods

National Grid selected the three specific sites for this evaluation from a random sample of fifteen Custom process projects to be evaluated.. The evaluation involved physical inspection of every installation, on-site metering, interviews with facility staff members, and engineering analyses. The following paragraphs describe the general approach taken to evaluate each site.

1.4.1 Review Application and Original Savings Methodology

UTS reviewed the descriptions of the projects and the savings calculation methodologies provided in the original applications. In particular, we assessed the reasonableness of the original approach to calculating savings. Whenever it was technically appropriate and possible, we attempted to mirror that approach in our re-evaluation of savings. Based on this review, we developed site measurement and evaluation plans for each site.

1.4.2 Visit Sites

We performed the following tasks, during our site visits:

1. Inspected and collected nameplate data for the new equipment.
2. Obtained scheduling and operational data through interviews with facility operators.
3. Took spot readings of amperage, voltage, power factors, and kW of affected equipment with a hand-held multi-meter and recording power meter.
4. Installed data loggers on equipment to be evaluated, and allowed loggers to record for 4 weeks or more.
5. Recorded all system-installed meter or gauge data (run time, temperatures, pressures, etc.) when we were at the site to install our metering equipment and later to remove it.

1.4.3 Analyze Data

General Approach

UTS's general approach for process projects starts with identification of the key parameters that affect the energy consumption and savings of the system. These include process load, weather, work and time off scheduling and equipment efficiencies. Metering is done for 4 weeks or more to understand the relationships between the variables. If the relationships are simple, the analysis may rely on a single calculation to represent annual energy use. If they are complex, a multivariable regression used in a bin-type of analysis may be warranted. UTS tries to adopt the methodology used in the application if it is reasonable and does not leave out important parameters and considerations.

1.5 Description of Evaluated Projects

One site was purchasing a new plastic injection molding machine (IMM) and two choices were available: hydraulic or all electric. The hydraulic IMM was less expensive and maintenance issues were well known because all the plant's other IMMs were hydraulic. They decided to purchase an all-electric IMM with utility incentives partially offsetting the more expensive first costs. The advantages of the all electric IMM go beyond using less energy; production is more repeatable and easier to set up thus reducing waste.

Another site was replacing their industrial annealing/curing ovens that reached the end of their useful life and needed to be replaced. They could have replaced them in kind, but chose to re-design their process and integrate in new, more efficient ovens. Now, their new smaller, better insulated and better controlled ovens are easier to load and unload, thereby causing less contamination between process steps and reducing waste.

The third project was to install VFDs on a water treatment plant's four raw water pumps. Flow through the pumps was previously controlled by motorized butterfly valves. The new VFDs now control the flow by adjusting the speed of the pumps' motors thereby saving energy and allowing for better control.

1.6 Results

1.6.1 Numerical Results

For the three applications that UTS evaluated, verified total unweighted energy savings comprised 126% of the annual energy savings claimed in the original Energy Initiative and Design 2000*plus* applications. We determined that 45% of these energy savings for these three projects is coincident with National Grid's old definition of on-peak period and 54% is coincident with the new on-peak period definition (the original applications indicated 42% of on-peak energy savings using the old definitions). Total un-weighted verified summer and winter peak coincident demand savings were 126% and 108% of the original projections, respectively using the old definitions and 130% and 110% using the new definitions. Detailed comparisons using the old definition are shown in Table 1-2 and for the new definition in Table 1-3 at the end of this section.

VFDs on the water treatment pumps dominated the savings figures. That project accounted for 84% of the evaluated kWh savings for all projects combined, compared to 63% of the applications' estimates. The VFD project's evaluated energy savings was 170% of its application's estimate. The other projects' evaluated savings were 54% of their applications' estimated energy savings.

1.6.2 Reasons for Differences between Tracking Estimates and Evaluation Results

For these projects, realization rates varied from a high of 170% to a low of 53%. Each site had its own reasons for the difference in savings.

Savings estimates are provided for seven quantities: % on-peak kWh and summer and winter coincident peak kW for both the old and new definitions and annual kWh. Table 1-1 lists the primary reasons for the differences in annual energy savings between the evaluation results and the projected savings.

Table 1-1: Summary of Annual Energy Savings Discrepancies

Site	Application	Eval/Track	Primary Reason for Discrepancy of Savings Estimate
1	VFDs on water treatment plant pumps	170%	Tracking analyst assumed frictional head loss of the original butterfly valves was less than determined in the evaluation.
2	All electric injection molding machine	56%	Tracking analyst assumed hours of operation was nearly twice that found by the evaluator.
3	New industrial heat treatment ovens	53%	Tracking analyst assumed base- and proposed-case ovens drew 22% more power than determined by the evaluator.

Reasons for savings discrepancies fell into the following categories:

1. *Assumed annual operating hours affected savings.* At Sites 2 and 3, equipment scheduling was different than noted in the application. Changes in equipment operating hours were -54% and -18% at Sites 2 and 3 respectively. Savings are tied directly to operating hours; fewer hours with all else being held constant, mean lower savings, while more hours mean larger savings.

2. *Some applications did not include savings analyses for components that received incentives or were integral to the project.* Improved motor efficiency was not included in the savings calculations for Site 1. Site 2 had a cooling tower, whose energy consumption was not considered. The savings estimates for Site 3 failed to include the energy use of a proposed-case exhaust fan (negative savings) but included savings from a component which would have used the same amount of energy in both pre- and post-cases.

3. *Poor assumptions affected savings.* At Site 1, the pressure drop through motorized control valves was underestimated and the reduction in pump efficiency was overestimated.

4. *How equipment was operated/controlled significantly affected savings.* At site 3, facility staff offered a different version of how the base-case was operated than was described in the application which was supported by apparently a-typical metered data. The metered data failed to capture the warm-up energy use of one large oven and underestimated operation of the other large oven.

1.7 Recommendations

Most tracking analyses' results were substantially different from the evaluated results. The main reasons for the differences are noted above. In general, the parameter that can be improved upon, almost universally, is to better estimate operating hours. Detailed conversations with operations staff and plant management are needed to better understand seasonal production cycles and plans for use of new equipment in relation to existing equipment.

If applicants are applying for incentives for components they should be required to calculate savings for those components. For example, Site 3 received incentives for an exhaust fan, but did not include energy calculations associated with it.

1.8 Description of How Results Are Used in Savings Calculation

The site-specific results reported here will be used to calculate case-weighted realization rates for each of the four savings parameters for the entire Custom process group population. These realization rates will be applied to all sites in tabulating the post-evaluation gross energy and demand savings.

Table 1-2: Custom Process Projects—Summary of Results
(with OLD definitions of On-Peak and Super Peak Demand periods)

					Nat. Grid TRACKING EST. SVGS				UTS EVALUATION SVGS				RATIO UTS / TRACKING			
						On-Peak	Peak Coinc. Sum.	Peak Coinc. Wint.		On-Peak	Peak Coinc. Sum.	Peak Coinc. Wint.		On-Peak	Peak Coinc. Sum.	Peak Coinc. Wint.
UTS ID	EI / D2	LOC ID	APPL #	CUSTOMER TYPE & LOCATION	kWh/yr	%	kW	kW	kWh/yr	%	kW	kW	kWh/yr	%	kW	kW
1	EI	4443095	503396	Water Treatment Plant, MA	518,209	37%	59.16	59.16	866,275	44%	104.60	89.20	170%	120%	180%	150%
2	D2	4147623	505249	Plastic Manufacturer, Leominster, MA	129,470	37%	15.24	15.24	72,558	50%	12.20	11.85	56%	136%	80%	78%
3	D2	4328815	217464	Plastic Manufacturer, Leominster, MA	170,708	61%	30.30	32.20	90,486	53%	14.70	14.50	53%	87%	49%	45%
				EI Subtotal	518,209	37%	59.16	59.16	866,275	44%	104.60	89.20	1.70	1.20	1.80	1.50
				D2 Subtotal	300,178	51%	45.54	47.44	163,044	52%	26.90	26.35	0.54	1.02	0.59	0.56
				Total	818,387	42%	104.7	106.6	1,029,319	45%	131.5	115.6	1.26	1.08	1.26	1.08

Table 1-3: Custom Process Projects — Summary of Results
(with NEW definitions of On-Peak and Super Peak Demand periods)

					Nat. Grid TRACKING EST. SVGS				UTS EVALUATION SVGS				RATIO UTS / TRACKING			
						On-	Peak Coinc.			On-	Peak Coinc.			On-	Peak Coinc.	
UTS	EI /	LOC	APPL	CUSTOMER		Peak	Sum.	Wint.		Peak	Sum.	Wint.		Peak	Sum.	Wint.
ID	D2	ID	#	TYPE & LOCATION	kWh/yr	%	kW	kW	kWh/yr	%	kW	kW	kWh/yr	%	kW	kW
1	EI	4443095	503396	Water Treatment Plant, MA	518,209	37%	59.16	59.16	866,275	52%	107.70	90.70	170%	140%	180%	150%
2	D2	4147623	505249	Plastic Manufacturer, Leominster, MA	129,470	37%	15.24	15.24	72,558	61%	13.89	11.81	56%	166%	91%	77%
3	D2	4328815	217464	Plastic Manufacturer, Leominster, MA	170,708	61%	30.30	32.20	90,486	65%	14.80	14.50	53%	106%	49%	45%
				EI Subtotal	518,209	37%	59.16	59.16	866,275	52%	107.70	90.70	1.70	1.40	1.80	1.50
				D2 Subtotal	300,178	51%	45.54	47.44	163,044	63%	28.69	26.31	0.54	1.25	0.63	0.55
				Total	818,387	42%	104.7	106.6	1,029,319	54%	136.4	117.0	1.26	1.28	1.30	1.10