Energy Efficiency Equals Energy, Economic, and Environmental Benefits

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ABSTRACT

To compensate for the scarcity of educational tools for energy-efficiency, performance contracting programs, Pacific Gas and Electric Co. (PG&E) is developing an electronic library of case studies and sample incentives applications with suggested measurement and verification (M&V) plans for some common, energy-efficiency projects in Northern California. The suggested M&V plans will explain how to monitor the baseline and post-retrofit electric or gas loads for the energy-efficiency projects. Market transformation partnerships and public-private partnerships with business, government, and community stakeholders can assist the project teams in evaluating and optimizing the complementary energy, economic, and environmental benefits of the energy-efficiency projects.

Introduction

The facility managers in Northern California mostly rely on their trade allies for the identification, evaluation, and implementation of energy-efficient technologies and best operating & maintenance practices. The trade allies include the equipment manufacturers, vendors, contractors, architects, engineers, and other consultants.

Pacific Gas and Electric Co. (PG&E) with authorization from the California Public Utilities Commission (CPUC) encourages utility customers and trade allies to upgrade existing facilities and construct new facilities with energy-efficient equipment through the "Customer Energy Efficiency (CEE) Programs." For CEE Program, educational and technical assistance, call 1-800-468-4743, or visit:
http://www.pge.com/customer_services/business/energy/smart/.

The "California Large Nonresidential Customer Standard Performance Contracting (LNSPC) Program" and the "California Small Business Customer Standard Performance Contracting (SBSPC) Program" provide financial incentives for electric or gas equipment upgrades in commercial, industrial, agricultural, institutional, and government facilities. The scarcity of educational tools for energy-efficiency, performance contracting programs may deter some facility managers and trade allies from participating in the LNSPC/SBSPC Programs. To overcome this market transformation barrier, PG&E is developing an electronic library of case studies and sample incentives applications with suggested measurement and verification (M&V) plans for some common, energy-efficiency projects in Northern California. These projects include high-efficiency dairy vacuum pumps with adjustable-speed-drives, high-efficiency building equipment, high-efficiency commercial washers, light-emitting-diode (LED) traffic signals, economizers for boilers, oversized

condensers for refrigeration systems, and membrane fine-bubble aerators for wastewater treatment plants. The suggested M&V plans will explain how to monitor the baseline and post-retrofit electric or gas loads for the energy-efficiency projects.

Market transformation partnerships and public-private partnerships with business, government, and community stakeholders can assist the project teams in evaluating and optimizing the complementary energy, economic, and environmental benefits of the energy-efficiency projects. Two effective, market transformation partnerships in the United States are "Energy Star" and the "Consortium for Energy Efficiency, Inc." Two effective, public-private partnerships in Northern California are "Stopwaste" and the "Department of Energy (DOE) Industrial Assessment Center (IAC) in the San Francisco State University (SFSU) School of Engineering."

Electric efficiency projects in Northern California usually reduce the natural gas fuel consumption, source emissions, and cooling tower water consumption in a gas-fired power plant on the electric grid. Gas efficiency projects usually reduce the natural gas fuel consumption and source emissions in the customer facility. Many energy-efficiency projects improve the productivity in the customer facility.

The preliminary analysis of a "High-Efficiency Dairy Vacuum Pump with an Adjustable-Speed-Drive" lays the groundwork for a case study of a simple SBSPC project. Similarly, the preliminary analysis of a "Department Store Upgrade with High-Efficiency Building Equipment" lays the groundwork for a case study of a complex LNSPC project.

California Large Nonresidential Customer Standard Performance Contracting Program

The "California Large Nonresidential Customer Standard Performance Contracting (LNSPC) Program" provides financial incentives for electric or gas equipment upgrades in larger business and government facilities. For complete LNSPC information, visit: *http://www.pge.com/customer_services/business/energy/spc/large_nr/.*

To qualify for a kWh savings incentive in the Pacific Gas and Electric Co. (PG&E) electric service area, the facility must be a PG&E electric distribution customer and pay the Public Goods Charge on the electric bill. To qualify for a therm savings incentive in the PG&E gas service area, the facility must be a PG&E gas distribution customer and pay the Demand Side Management Charge on the gas bill. Overall, the LNSPC project must save at least 100,000 kWh annually, or 10,000 therms annually.

The project sponsor, who may be either the host customer or a trade ally, may apply to the LNSPC Program by submitting a Project Application to PG&E, the Utility Administrator in Northern California. The project sponsor is responsible for project implementation including design, procurement, installation, commissioning, and measurement and verification.

The baseline energy consumption for the LNSPC project is computed for the existing or better system or equipment that meets all required codes and standards. The post-retrofit energy consumption is computed for the upgraded system or equipment that meets all required codes and standards.

The LNSPC incentive is paid in three installments over a two-year, performance monitoring period after project installation. The total incentive is computed for one year of measured and verified kWh savings and / or therm savings at the incentive rates in Table 1.

Table 1. LNSPC Incentive Rates
$ 0.05 per kWh for Lighting Measures
$ 0.165 per kWh for Air Conditioning and Refrigeration Measures
$ 0.08 per kWh for Motors and Other Electric Measures
$ 0.27 per therm for Gas Measures

California Small Business Customer Standard Performance Contracting Program

The "California Small Business Customer Standard Performance Contracting (SBSPC) Program" provides financial incentives for electric or gas equipment upgrades in smaller business and government facilities. For complete SBSPC information, visit: *http://www.pge.com/customer_services/business/energy/spc/small_nr/.*

To qualify for a kWh savings incentive in the Pacific Gas and Electric Co. (PG&E) electric service area, the facility must be a PG&E electric distribution customer and pay the Public Goods Charge on the electric bill. The facility must have an electric demand of less than 500 kW. To qualify for a therm savings incentive in the PG&E gas service area, the facility must be a PG&E gas distribution customer and pay the Demand Side Management Charge on the gas bill. The facility must use less than 250,000 therms of gas annually. Overall, the SBSPC project must save at least 10,000 kWh annually, or 2,000 therms annually.

The project sponsor, who must be a trade ally of the host customer, may apply to the SBSPC Program by submitting a Project Application to PG&E, the Utility Administrator in Northern California. The project sponsor is responsible for project implementation including design, procurement, installation, commissioning, and measurement and verification.

The baseline energy consumption for the SBSPC project is computed for the existing or better system or equipment that meets all required codes and standards. The post-retrofit energy consumption is computed for the upgraded system or equipment that meets all required codes and standards.

The SBSPC incentive is paid in two installments over a one-year, performance monitoring period after project installation. The total incentive is computed for one year of measured and verified kWh savings and / or therm savings at the incentive rates in Table 2. The Host Customer Participation Incentive applies to the first SBSPC project in the customer facility.

Table 2. SBSPC Incentive Rates	Maximum, Host Customer Participation Incentive
$ 0.055 per kWh for Lighting Measures	$ 1,000
$ 0.185 per kWh for Air Conditioning and Refrigeration Measures	$ 2,500
$ 0.09 per kWh for Motors and Other Electric Measures	$ 1,500
$ 0.34 per therm for Gas Measures	$ 1,500

Preliminary Analysis of a High-Efficiency Dairy Vacuum Pump with an Adjustable-Speed-Drive

This preliminary analysis of a "High-Efficiency Dairy Vacuum Pump with an Adjustable-Speed-Drive" lays the groundwork for a detailed case study of a simple "California Small Business Customer Standard Performance Contracting (SBSPC)" project:

A dairy equipment contractor installed a new, high-efficiency vacuum pump in a medium-size dairy. The new pump has a 25 hp, premium-efficiency motor with an adjustable-speed-drive (ASD). The ASD varies the motor speed to control the vacuum pressure in the milk lines.

The old, standard-efficiency vacuum pump had a 30 hp, standard-efficiency motor. An inefficient vent valve in the suction header controlled the vacuum pressure in the milk lines.

The new pump operates at low motor speed and low electrical load[1] (about 9 kW) during the milking hours (about 18 hours per day). The new pump operates at high motor speed and high electrical load[1] (about 22 kW) during the cleaning hours (about 2 hours per day). The old pump operated at high motor speed and high electrical load[2] (about 26 kW) during the milking and cleaning hours.

Table 3 summarizes the main energy and economic benefits for the new, high-efficiency dairy vacuum pump. The new pump should have a lower lifecycle cost than the old pump. Table 4 summarizes the energy equations for Table 3. Table 5 summarizes the associated energy, air quality, and water conservation benefits in a gas-fired power plant on the electric grid.

This preliminary analysis does not assess the potential side benefits in the dairy: The new pump should be more reliable and last longer than the old pump. The cows may be less stressed and more productive because of less udder wear.

[1] Use a portable power meter to measure the total electrical load (true power in kW) on the ASD input circuit

[2] Use a portable power meter to measure the total electrical load (true power in kW) on the motor input circuit.

Table 3. Main Energy and Economic Benefits[3] for the New, High-Efficiency Dairy Vacuum Pump	**Preliminary Estimates**
Baseline kWh Consumption	190,000 kWh per year
Post-Retrofit kWh Consumption	75,000 kWh per year
Total kWh Savings	115,000 kWh per year
Summer Peak-Period kW Demand Savings	17 kW
Total Electricity Cost Savings @ $ 0.08 per kWh	$ 9,200 per year
Estimated, California Small Business Customer Standard Performance Contracting (SBSPC) Incentive	$ 12,000 total
Estimated, Simple Payback Period with SBSPC Incentive	Less than Two Years

Table 4. Energy Equations for Table 3
Baseline kWh Consumption = 190,000 kWh = = [(26 kW during Milking and Cleaning Hours)* (20 Milking and Cleaning Hours per Day) * (365 days/year)]
Post-Retrofit kWh Consumption = 75,000 kWh = = { [(9 kW during Milking Hours)* (18 Milking Hours per Day) + (22 kW during Cleaning Hours)* (2 Cleaning Hours per Day)]* (365 days/year)}
Total kWh Savings = 115,000 kWh = 190,000 kWh - 75,000 kWh
Summer Peak-Period kW Demand Savings = 17 kW = 26 kW - 9 kW

Table 5. Associated Power Plant Benefits[4] for the New, High-Efficiency Dairy Vacuum Pump	**Preliminary Estimates**
Natural Gas Fuel Savings	12,000 therms per year
Reduction in Carbon Dioxide (CO_2) Emissions	65 tons per year
Reduction in Oxides of Nitrogen (NO_x) Emissions	36 pounds per year
Cooling Tower Water Savings	52,000 gallons per year

[3] Refer to the energy equations in Table 4.

[4] Assume a gas-fired power plant, 10,000 Btu/kWh incremental heat rate, 4,000 Btu/kWh latent heat rejection in the power plant cooling tower, and 30 ppmv NO_x @ 3%O_2.

Preliminary Analysis of a Department Store Upgrade with High-Efficiency Building Equipment

This preliminary analysis of a "Department Store Upgrade with High-Efficiency Building Equipment" lays the groundwork for a detailed case study of a complex "California Large Nonresidential Customer Standard Performance Contracting (LNSPC)" project. The energy-efficiency measures include:

- Replace the inefficient incandescent lamps and T12 fluorescent lamps and magnetic ballasts with efficient T5 and T8 fluorescent lamps, compact fluorescent lamps, and electronic ballasts. Install light-emitting-diode (LED) exit signs. Where practical, install task lighting, reflectors, timers and occupancy controls. The room surfaces should be white or near-white to reflect the light.
- Upgrade the building insulation and glazing to minimize the heating and cooling losses. Where practical, install skylights, low-emissivity (low-E) glass, and an insulated roof with reflectorized coating.
- Install efficient chillers. Install an oversized condenser with adjustable-speed-drives (ASDs) on the fans and pumps to minimize the auxiliary loads. Install a free cooling loop to bypass the chillers during the early morning and at night.
- Install an energy management system to control the lighting system and the heating, ventilation, and air conditioning (HVAC) system.

Table 6 summarizes the main energy and water conservation benefits for the new, high-efficiency building equipment in the department store (on a typical, warm summer day). The new equipment should have a lower lifecycle cost than the old equipment. Table 7 summarizes the associated energy, air quality, and water conservation benefits in a gas-fired power plant on the electric grid.

This preliminary analysis does not assess the potential side benefits for the new, high-efficiency building equipment in the department store: The new equipment should be more reliable and last longer than the old equipment. The salespeople and shoppers may be less stressed because of the improved visual and space conditions. The salespeople may be more productive, and the shoppers may buy more goods.

Table 6. Main Energy and Water Conservation Benefits for the Upgraded Department Store (on a Typical, Warm Summer Day)	**Preliminary Estimates**
Baseline kWh Consumption, from Electric Billing Analysis	13,000 kWh per day
Post-Retrofit kWh Consumption, from Electric Billing Analysis	8,000 kWh per day
Total kWh Savings, from Electric Billing Analysis	5,000 kWh per day
Summer Peak-Period kW Demand Savings, from Electric Billing Analysis	300 kW
Total Electricity Cost Savings @ $ 0.08 per kWh, from Electric Billing Analysis	$ 400 per day
Evaporative Condenser Water Savings, from Water Billing Analysis	1,000 gallons per day

Table 7. Associated Power Plant Benefits[5] for the Upgraded Department Store (on a Typical, Warm Summer Day)	Preliminary Estimates
Natural Gas Fuel Savings	500 therms per day
Reduction in Carbon Dioxide (CO2) Emissions	3 tons per day
Reduction in Oxides of Nitrogen (NOx) Emissions	2 pounds per day
Cooling Tower Water Savings	2,300 gallons per day

Stopwaste Partnership

The Stopwaste public-private partnership assists clients in facilitating waste reduction & recycling, energy-efficiency, and water conservation projects in business and government facilities in Alameda County, California. Stopwaste is sponsored by the Alameda County Waste Management Authority & Source Reduction and Recycling Board, *http://www.stopwaste.org/.*

The Stopwaste technical partners include the Economic Development Alliance for Business (EDAB) in Alameda County, Pacific Gas and Electric Co. (PG&E), East Bay Municipal Utility District (EBMUD), and Science Applications International Corp. (SAIC). Stopwaste provides free expert assistance to minimize waste, conserve energy and water, and use all resources more efficiently. Stopwaste tailors a solution that fits the client's needs, from starting an office recycling program, to technical assistance for improving manufacturing processes. Stopwaste assesses and baselines the operations. Stopwaste provides cost-cutting recommendations and sets performance goals. Stopwaste implements the best performance strategies and measures the results. Stopwaste secures financial support for developing, demonstrating, and implementing waste reduction & recycling processes. Stopwaste provides waste reduction & recycling guides, workshops, seminars, and policy support. Stopwaste recognizes clients for their accomplishments.

[5] Assume a gas-fired power plant, 10,000 Btu/kWh incremental heat rate, 4,000 Btu/kWh latent heat rejection in the power plant cooling tower, and 30 ppmv NO_x @ 3%O_2.

Department of Energy (DOE) Industrial Assessment Center (IAC) in the San Francisco State University (SFSU) School of Engineering

The student and faculty teams from the Department of Energy (DOE) Industrial Assessment Center (IAC) in the San Francisco State University (SFSU) School of Engineering assist clients in evaluating the energy-efficiency, water conservation, waste reduction & recycling, and productivity improvement opportunities in many types of industrial and agricultural facilities in Northern California. Other IACs are located in the University of Nevada-Reno (UNR) and San Diego State University (SDSU) Schools of Engineering. For IAC Program, educational, and technical assistance, visit: *http://www.oit.doe.gov/iac/.* The IAC survey criteria are:

- Within Standard Industrial Codes (SIC) 20-39 manufacturing; SIC 1-8 crops, agricultural services and forestry; SIC 10-14 mining and extraction.
- No professional in-house staff to perform the assessment.
- Gross annual sales below $ 75 million (some exceptions allowed).
- Fewer than 500 employees at the plant site (some exceptions allowed).
- Annual energy bills more than $ 75,000 and less than $ 1.75 million (some exceptions allowed).
- Within about 150 miles of a host campus (some exceptions allowed).

Conclusions

Pacific Gas and Electric Co. (PG&E) with authorization from the California Public Utilities Commission (CPUC) encourages utility customers and trade allies to upgrade existing facilities and construct new facilities with energy-efficient equipment through the "Customer Energy Efficiency (CEE) Programs." The two main CEE Programs for customized, business/government facility upgrades are the "California Large Nonresidential Customer Standard Performance Contracting (LNSPC) Program" and the "California Small Business Customer Standard Performance Contracting (SBSPC) Program."

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