FORT DRUM INTEGRATED RESOURCE ASSESSMENT
VOLUME 3: RESOURCE ASSESSMENT

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MASTER

ABSTRACT

The U.S. Army Forces Command (FORSCOM) has tasked Pacific Northwest Laboratory (PNL)^(a) as the lead laboratory supporting the U.S. Department of Energy (DOE) Federal Energy Management Program's (FEMP) mission to identify, evaluate, and assist in acquiring all cost-effective energy projects at Fort Drum. This is a model program PNL is designing for federal customers served by the Niagara Mohawk Power Company (Niagara Mohawk). It will 1) identify and evaluate all electric and fossil fuel cost-effective energy projects; 2) develop a schedule at each installation for project acquisition considering project type, size, timing, capital requirements, as well as energy and dollar savings; and 3) secure 100% of the financing required to implement electric energy efficiency projects from Niagara Mohawk and have Niagara Mohawk procure the necessary contractors to perform detailed audits and install the technologies.

This report provides the results of the fossil fuel and electric energy resource opportunity (ERO) assessments performed by PNL at one of Niagara Mohawk's primary federal facilities, the FORSCOM Fort Drum facility located near Watertown, New York. It is a companion report to Volume 1, the Executive Summary, and Volume 2, the Baseline Detail.

The results of the analyses of EROs are presented in 14 common energy end-use categories (e.g., Lighting EROs, Boiler and Furnace EROs, HVAC System EROs). A narrative description of each ERO is provided, including information on the initial cost, energy and dollar savings; impacts on operations and maintenance (O&M); and, when applicable, a discussion of energy supply and demand, energy security, and environmental issues. A description of the evaluation methodologies and technical and cost assumptions is also provided for each ERO. Summary tables present the operational performance of energy end-use equipment before and after the implementation of each ERO and present the results of the life-cycle cost analysis indicating the net present value (NPV) and value index (VI) of each ERO.

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Analysis results are presented in four categories representative of Fort Drum: New Post, Old Post, on-post family housing, and off-post family housing. Savings are indicated by fuel type: fuel oil #2 (FO2), natural gas (NG), high-temperature hot water (HTHW), propane, and electricity.

Individual EROs were evaluated as mutually exclusive measures (with the exception of occupancy sensors, which was evaluated with both current and recommended lighting configurations). This approach allows individual EROs to be ranked or rated based on parameters such as initial cost, energy savings, and changes in O&M requirements in addition to NPV and VI. Economic analyses reflect current actual energy cost and government projections both of fuel price escalations and inflation rates.

SUMMARY

The U.S. Army Forces Command (FORSCOM) has tasked Pacific Northwest Laboratory (PNL) as the lead laboratory supporting the U.S. Department of Energy (DOE) Federal Energy Management Program's (FEMP) mission to identify, evaluate, and assist in acquiring all cost-effective energy projects at Fort Drum. This is a model program PNL is designing for federal customers served by the Niagara Mohawk Power Company (Niagara Mohawk). This report describes the methodology used to identify and evaluate the energy resource opportunities (EROs) at Fort Drum, provides a life-cycle cost (LCC) analysis for each ERO, and prioritizes the EROs based on their net present value (NPV) and value index (VI). Analysis results are presented in 14 common energy end-use categories (e.g., Lighting, HVAC, Refrigeration) and the four building groups representative of Fort Drum: New Post, Old Post, on-post family housing, and off-post family housing. Savings are indicated by fuel type: fuel oil #2, natural gas, propane, high-temperature hot water (HTHW), and electricity.

As illustrated in Table S.1, the present value of the installed cost of all cost-effective EROs at Fort Drum is nearly \$17 million (1992 \$). The present value of the savings associated with this investment is approximately \$47 million (1992 \$), for an overall NPV of \$30 million. By implementing all the cost-effective EROs identified in this study, Fort Drum will reduce annual energy use by 233,579 MBtus (15%). Annual energy expenditures will decrease by over \$2.7 million (23%).

Table S.2 provides a complete breakdown and summary of the electric efficiency resource at Fort Drum.

TABLE S.1. Total Savings, Cost, and NPV (1992 \$)

Total Present Value of Installed Cost ^(a)	Total Present Value of Energy Savings	Total Present Value of Demand Savings	Total Present Value of O&M Savings	Total Present Value of All Savings	Total Net Present Value ^(a)
\$16,478,259	\$34,018,474	\$6,233,134	\$6,621,546	\$46,873,154	\$30,644,466

(a) Totals in Table S.1 will not equal sum of Tables S.2 and S.3 because Peak-Shave and CO₂ Sensor EROs are accounted for in both the Fossil and Electric Resource Summary tables.

TABLE S.2. Summary of the Electric Efficiency Resource at Fort Drum

Energy Resource Opportunity Category	Present Value of Installed Cost ^(a) (1992 \$)	Annual Energy Savings (kWh)	Value of Annual Energy Savings (1992 \$)	Annual Demand Savings (kW-mo)	Value of Annual Demand Savings (1992 \$)	Total Net Present Value (1992 \$)
Air-Conditioning	31,850	25,093	1,470	225	1,241	8,393
CO ₂ Sensors ^(b)	56,430	154,028	7,659	0	0	37,639
Lighting	7,940,028	18,078,203	1,011,494	46,501	256,218	16,578,499
Fluorescents	4,227,477	9,512,174	513,182	28,250	155,656	7,014,250
Incandescents	3,123,671	6,922,986	419,014	15,396	84,833	6,551,533
Exits	530,740	1,020,584	50,825	1,398	7,703	2,476,115
HIDs ^(c)	58,140	622,458	28,473	1,457	8,026	536,600
Motors ^(c)	477,618	3,387,177	172,059	-1,907	-11,635	1,549,979
Peak-Shave ^(b)	194,000	4,000,000	234,360	31,200	171,912	1,362,873
Streetlights	83,784	1,073,557	49,735	2,596	14,304	938,318
Trans. & Dist.	8,522	756,954	38,291	1,332	7,340	883,150
Weatherization	63,850	197,066	9,767	583	3,212	118,860
Total	\$8,856,082	27,672,078	\$1,524,835	80,530	\$442,592	\$21,477,711

(a) Analysis assumes no utility cost-sharing.

(b) The NPVs of peak-shave and CO₂ sensors include fossil costs/savings.

(c) An additional present value of \$171,897 corresponds to replace on failure installed costs. These were included in the present value of O&M Savings category in the NPV calculation.

The *Lighting ERO* category has the greatest potential at Fort Drum. Lighting EROs alone represent almost 70% of the potential reduction in electricity use identified in this study and include the replacement/retrofit of existing lighting equipment with T-8 bulbs, electronic ballasts, optical reflectors, high-pressure sodium and compact fluorescent fixtures, and occupancy sensors.

The use of energy-efficient and two-speed motors accounts for 12% of the kWh savings, and transmission and distribution EROs such as power factor correction and conservation voltage reduction account for slightly under 3% of total electrical savings.

Demand charges constitute approximately 10% of Fort Drum's monthly electric bill. These charges can be reduced by using existing emergency service diesel generators to carry part of the on-post electric load whenever demand approaches the monthly peak. The most reliable and effective way to accomplish this is to modify selected generators, so that they can be used as a power source that can feed into Fort Drum's electrical distribution system. The *Peak Shaving with Existing Diesel Generators ERO* has a high NPV given the

fuel oil prices and electricity rates (FY 1991) used in this analysis. However, this ERO is very sensitive to the price of fuel oil, which has been volatile in the past. In addition to closely monitoring fuel oil costs, cooperation with Niagara Mohawk is advised when considering the implementation of this ERO. Currently, Niagara Mohawk does not offer inducements for customer-owned and operated "back-up" power sources; however, as a result of the least-cost planning approach being advocated by regulatory commissions, this load management alternative is becoming more common. It is possible that Niagara Mohawk may offer rate incentives for peak shaving with diesel generators in the future.

A summary of the savings potential categorized by fossil fuel resources is presented in Table S.3.

The Old Post, consisting predominantly of World War II-vintage buildings heated with fuel oil, offers opportunities for fuel-switching to natural gas and replacement or conversion of aging and inefficient boilers, furnaces, and water heaters to new high-efficiency units.

Although most of the buildings on the Old Post have been renovated over the years and have storm windows or double-pane glass and some thermal

TABLE S.3. Summary of Fossil Fuel Resource at Fort Drum

Energy Resource Opportunity Category	Present Value of Installed Cost ^(a) (1992 \$)	Annual Energy Savings (MBtu)	Value of Annual Energy Savings (1992 \$)	Total Net Present Value (1992 \$)
Peak-Shave ^(b)	194,000	-43,451	-216,000	1,362,873
CO ₂ Sensors ^(b)	56,430	2,221	9,539	37,639
Controls	66,090	6,790	31,112	458,647
Furn. & Boilers	2,953,444	51,658	362,185	2,752,818
Hot Water	710,524	8,679	70,730	448,266
Trans. & Dist.	70,130	52,750	226,561	3,749,684
Weatherization	<u>3,821,989</u>	<u>60,513</u>	<u>318,136</u>	<u>1,757,340</u>
Total	\$7,872,607	139,161	\$802,263	\$10,567,266

(a) Analysis assumes no utility cost-sharing.

(b) The NPVs of peak-shave and CO₂ sensors include electric savings.

insulation, significant opportunities still exist for weatherization measures such as weatherstripping, floor and additional ceiling insulation, and window quilts.

The heating systems in many of the Old Post buildings are currently regulated by a radio control system that consists of a central computer and an FM transmitter, with a receiver and a day thermostat and a night thermostat in each building. Fort Drum has already purchased much of the hardware required to add most of remaining Old Post buildings to the FM control system. A very cost-effective opportunity exists by funding the installation of this equipment.

Large energy and dollar savings can be also be realized through the repair or replacement of pipe insulation on the HTHW distribution system servicing the New Post. In addition, several sections of the HTHW loop that currently do not provide service to buildings could be decommissioned, resulting in reduced pipeline heat loss and additional dollar savings.

On- and off-post housing units, although relatively well insulated, are prone to draftiness. A "weatherization package" consisting of attic hatch insulation, switchplate gaskets, caulking, and filling plumbing holes and other penetrations with insulation was found to be life-cycle cost-effective, as were window quilts, which provide insulation and reduce infiltration. Finally, the all-electric, on-post family housing units have insufficient ceiling insulation; increasing the insulation in these units up to an R-60 level will be life-cycle cost-effective.

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1.0 SELECTION OF ENERGY RESOURCE OPPORTUNITIES

The number of conceivable energy conservation measures, fuel-switching opportunities, and renewable energy projects at a federal site is very large. A three-step process has been developed by PNL^(a) to make energy resource opportunity (ERO) selection, evaluation, and prioritization manageable. The steps are the following:

- Preliminary Screening. Select promising EROs from the master list, considering the site's mission, building stock, end-use equipment characteristics, utility characteristics, climate, energy costs, and other local conditions that affect ERO viability.
- Cost and Performance Analysis. Establish, with a reasonable degree of accuracy, the technical and economic feasibility of each ERO that passed the preliminary screening. An analysis is performed comparing the operating and economic performance of the existing equipment and the ERO. Where applicable, impacts on energy security and the environment are included in the analysis.
- Life-Cycle Cost Analysis and Prioritization. Perform a life-cycle cost analysis and rank EROs by net present value (NPV), so that a package with the optimal return on site and utility investment can be defined. Utility- and technology-specific incentives are accounted for in this evaluation step.

The third step, life-cycle cost analysis and prioritization of EROs, is required by federal law (CFR 436, Part 10). All federal agencies are required to evaluate the life-cycle cost (LCC) of potential energy investments. An LCC evaluation computes the total long-run costs of a number of potential actions, and selects the action that minimizes the long-run costs and maximizes the NPV of the energy investment. Section 3.1 details the process by which LCCs are calculated, explains how these calculations are used in the selection of projects, and introduces a method for prioritizing a list of selected actions.

The remainder of Section 1.0 describes the process used for preliminary selection of ERO and presents the master list of screened and selected EROs. Section 2.0 covers the technical characteristics of each conservation and

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fuel-switching measure considered and analyzes its cost and performance, and Section 3.0 provides the results of the life-cycle cost analysis and ERO prioritization process. Section 4.0 lists the references used in this study.

1.1 ERO PRELIMINARY SELECTION CRITERIA

The ERO selection process tests the applicability of a long list of EROs (see the master list of EROs in Table 1.1) using a set of criteria that can be applied with relatively little "hard data." This step filters out EROs that are unlikely to be economically feasible, are unlikely to have significant, persistent energy impact at the site, or that will be unduly expensive or difficult to analyze. The eight basic criteria used to characterize and select possible EROs are listed below.

- **Low Incidence.** EROs that apply to end use equipment representing a very small fraction of site energy use may be eliminated. However, such EROs may be retained in cases where the end-use is concentrated rather than diffuse, or where it has been previously identified in a detailed audit, and the ERO passes the other criteria without difficulty.
- **Economic Feasibility.** A preliminary assessment of economic feasibility can often be made if the utility will commit to an incentive or cost-sharing level in advance. Energy resource opportunities whose costs and performance are well established and fairly uniform across applications can then be screened with respect to the utility's marginal cost of energy supply.
- **Technical Feasibility.** In some cases, conditions at the site will preclude implementation of a certain ERO. Conditions that make retrofit difficult or use patterns that complicate operations or maintenance of the end-use equipment in question may result in elimination of an ERO prior to formal analysis.
- **Primarily Operations and Maintenance (O&M).** A measure that is little more than a no- or low-cost change in O&M activity will generally be rejected as inappropriate to the integrated resource acquisition program. The measures of interest to the program are capital intensive measures that are difficult, programmatically, for the site personnel to implement on their own. Cases where there is a significant cost to develop new O&M procedures or to procure special instruments and tools may be considered.
- **Mission-Critical.** End-use equipment that serves critical mission functions may not be accessible for retrofit or replacement, or its operation may be so important to critical mission objectives that any reduction or change in the service is not tolerable.

- **Site Preference.** The site may have particular objections to certain EROs, based on O&M or other infrastructure support requirements, or based on unfavorable past experience with similar measures. In cases where the ERO appears to be very attractive in other respects, it may be analyzed in the belief that the savings might support a reevaluation of the measure.
- **Insufficient Data.** In some cases, the performance or operational characteristics of existing end-use equipment is unknown, and the cost for an outside consultant to determine these characteristics cannot be justified. This is not a technical- or implementation-cost grounded rejection and should not deter the resident site energy and O&M staff or local energy service company personnel from further analysis and, if appropriate, implementation of the ERO concerned.
- **Complexity.** In some cases, the complexity of the analysis precludes the analysis of an ERO as part of a high-level, comprehensive site assessment program.
- **Immature Technology.** Some retrofits require equipment that has not achieved sufficient market acceptance or penetration in the federal sector to be considered reliable and effective in the field. The persistence of savings and the sensitivity of savings to O&M, and the propensity for equipment to degrade in energy performance while continuing to provide service, are factors that could disqualify a technology. Such measures will usually not be considered.
- **Other ERO-Dependent Measures.** A measure may be rejected because it depends on one or more other EROs that have been rejected or whose feasibility is too uncertain. It may also be rejected because it has already been implemented in most or all of the existing end-use opportunities.

1.2 MASTER LIST OF SCREENED AND SELECTED EROs

A master list of generic conservation measures, aggregated from a variety of sources, was used as an origination point in the identification of energy resource opportunities at Fort Drum.^(a) This master list is presented

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- (a) Institutional Conservation Program Workshop Manual, Energy Analysis and Diagnostic Center Directory of Industrial Energy Conservation Opportunities (ECOs), Competitek Information Service, Pacific Gas & Electric Application Notes, Association of Energy Engineers boiler and motor books, American Council for an Energy Efficient Economy motor book, the Architect's and Engineer's Guide to Energy Conservation in Existing Buildings - Volume 2 (1990), and in-house expertise.

in Table 1.1. For each ERO listed there is an indication of whether or not it passed the preliminary selection process. If the ERO did not pass, a brief explanation is provided.

TABLE 1.1. Master List of Energy Resource Opportunities at Fort Drum

<u>ERO Name</u>	<u>ERO Description</u>	<u>Evaluated (Y/N)</u>	<u>Comment</u>
<u>FANS AND FAN MOTORS</u>			
Align sheaves	Align sheaves and shafts; replace belt with high-efficiency belt(s).	N	This is primarily an O&M measure
Reduce hours	Install clock, EMCS switch or other control means to reduce operating hours.	N	Use alternate ERO: CO ₂ sensors
Reduce speed	Reduce fan speed by adjusting sheave diameter and reduce motor size accordingly.	N	Insufficient data
Efficient motor	Replace existing motor with high-efficiency model and reduce size if appropriate.	Y	
Two-speed motor	Replace existing motor with two-speed motor and controller.	Y	
Variable inlet vane	Install variable inlet vanes and control to provide reduced air flow when appropriate.	N	Most fans are single zone
Variable-speed drive	Install variable frequency motor drive and control to modulate airflow; also reduce motor size if appropriate.	N	Most fans are single zone
Variable-speed electronically commutated motor	Replace existing motor with variable-speed electronically commutated permanent magnet motor and control; also reduce motor size if appropriate.	N	Most fans are single zone
CO ₂ sensor	Install CO ₂ sensors for ventilation control reduce heating of outside air and average (over time) air volume moved by fans.	Y	
Duct transitions	Redesign duct transitions to reduce friction loss by using turning vanes, long radius turns and gradual changes in cross-sectional area.	N	No high SP systems; insufficient data on low SP systems
Duct cross-section	Increase duct cross-section to reduce friction loss.	N	No high SP systems; insufficient data on low SP systems
Face velocity	Redesign filters, coils, etc., to reduce friction loss by operating at lower face velocities.	N	No high SP systems; insufficient data on low SP systems
<u>PUMPS AND PUMP MOTORS</u>			
Align shafts	Align shafts and replace coupling with high-efficiency coupling.	N	This is primarily an O&M measure
Reduce hours	Install clock, EMCS switch or other control means to reduce operating hours.	N	Most pumps operate on demand
Efficient motor	Replace motor with high-efficiency model.	Y	

TABLE 1.1. (contd)

ERO Name	ERO Description	Evaluated (Y/N)	Comment
Trim impeller	Replace (or trim) impeller and reduce motor size to match actual load.	N	Insufficient data
Two-speed motor	Replace existing motor with two-speed motor and controller.	Y	
Variable-speed drive	Install variable frequency motor drive and control to modulate fluid flow; also reduce motor size if appropriate.	N	Large pumps already VSD (except DANC pumps: n/s data)
Variable-speed, electronically commutated motor	Replace existing motor with variable-speed electronically commutated permanent magnet (VS ECM) motor and control; also reduce motor size if appropriate.	N	Large pumps already VSD (except DANC pumps: n/s data)
Adjust VSD setpoint	Adjust VSD control setpoint for lower speed operation.	Y	
Pipe transitions	Redesign system with long radius elbows and other low-loss type fittings to reduce friction loss.	N	Insufficient data
Pipe size	Redesign system with increased pipe diameter to reduce friction loss.	N	Insufficient data
Fittings	Redesign filters, heat exchangers, valves, etc., to reduce friction loss by operating at lower velocity.	N	Insufficient data
<u>REFRIGERATION (residential/barracks)</u>			
Efficient refrigerator (1993)	Replace existing refrigerator with high-efficiency model meeting DOE 1993 Appliance Efficiency Standard.	Y	
Efficient refrigerator (1996)	Replace existing refrigerator with high-efficiency model meeting BPA proposed 1996 refrigerator efficiency standard.	N	Not cost effective
<u>AIR-CONDITIONING (window or package units)</u>			
Efficient air-conditioner	Replace window or package air-conditioner with high-efficiency model.	Y	
Reduce A/C hours	Install clock, EMCS switch or other control means to reduce operating hours and peak coincident load of air-conditioner.	N	Little data on wasteful (unoccupied) operation
<u>LIFT STATION heating/ventilation</u>			
Thermostat	Replace on/off control of electric resistance heater control with thermostatic control.	Y	
Ventilation heat recovery	Install air-to-air heat exchanger to preheat ventilation air by recovering sensible and latent heat from exhaust.	N	Insufficient experience with ERO

TABLE 1.1. (contd)

<u>ERO Name</u>	<u>ERO Description</u>	<u>Evaluated (Y/N)</u>	<u>Comment</u>
Methane sensor control	Provide methane sensor to operate ventilation fan only when needed to prevent excess methane concentrations.	N	Insufficient experience with this ERO
Insulate walls	Install moisture-resistant insulation to above-grade walls and roof (consider this ERO only after thermostat and ventilation heat recovery or methane sensor).	N	Must be preceded by ventilation control ERO
<u>RESIDENTIAL LIGHTING (interior and exterior)</u>			
Upgrade incandescent to PCF fixture	Upgrade incandescent fixture to permanent compact fluorescent fixture.	Y	
Replace incandescent with PCF fixture	Replace incandescent fixture with new compact fluorescent fixture.	Y	
Upgrade fluorescent to T8	Upgrade fluorescent to high-efficiency T8 or similar system.	Y	
Replace fluorescent with new fixture	Replace fluorescent fixture with new high-efficiency T8 (or comparable) fixture.	Y	
<u>COMMERCIAL LIGHTING</u>			
Upgrade fluorescent to T8	Upgrade fluorescent fixture to high-efficiency T8 or similar system.	Y	
Replace fluorescent with new fixture	Replace fluorescent fixture with new high-efficiency T8 (or comparable) fixture.	Y	
De-lamp	Replace, modify or move/remove fixtures to reduce lighting density to level that provides correct illumination.	Y	
Upgrade incandescent to PCF fixture	Upgrade incandescent fixture to permanent compact fluorescent fixture.	Y	
Replace incandescent with PCF fixture	Replace incandescent fixture with new compact fluorescent fixture.	Y	
Upgrade mercury to HP sodium	Replace mercury vapor lamps and ballasts with high-pressure sodium lamp and ballast (or replace entire fixture).	Y	
Upgrade incandescent exit signs	Upgrade incandescent exit signs with LED or fluorescent exit signs.	N	More economical to replace whole unit
Replace incandescent exit signs	Replace incandescent exit signs with LED or fluorescent exit signs.	Y	
Occupancy sensors	Install occupancy sensors to control lights.	Y	
Time clocks or photocells	Install time clocks or photocells to control lights.	N	Occupancy sensors preferred

TABLE 1.1. (contd)

<u>ERO Name</u>	<u>ERO Description</u>	<u>Evaluated (Y/N)</u>	<u>Comment</u>
EMCS control	Install EMCS or add field panel and necessary relays to control lights via EMCS system.	N	Occupancy sensors preferred
<u>EXTERIOR LIGHTING</u>			
De-lamp	Remove or disconnect bulbs or ballasts to reduce lighting density to level that provides reduced but satisfactory illumination.	Y	
Zoned security lamp circuits	Rewire building exterior light circuits into zones so that night work lights and security lights are under separate control.	Y	
Motion detectors	Install motion detectors in series with security light time clock switch so that selected zones are off except when activated by motion detectors.	N	Zoning preferred
Reprogram time clocks	Reprogram existing time clock to turn off or reduce light level at low traffic hours.	Y	
Install time clocks	Install programmable time clock to turn off or reduce light level at low traffic hours.	N	Clock already in place
Zoned streetlamp circuits	Rewire streetlight circuits into zones and provide programmable time clock to turn off or reduce light level at low traffic hours.	Y	
Mercury to HP sodium	Replace mercury vapor lamps and ballasts with high-pressure sodium lamp and ballast (or replace entire fixture).	Y	
Incandescent to HP sodium	Replace incandescent fixture with high-pressure sodium fixture.	Y	
<u>OCCUPANCY-BASED CONTROLS (see also FAN, HVAC)</u>			
Occupancy sensor, restroom	Install occupancy sensor to control lights and exhaust fan in restroom.	Y	
Occupancy sensor, other	Install occupancy sensor to control lights in hallway, lunchroom, office, conference room, or other intermittently occupied area.	Y	
Daylight sensor	Install daylight sensor to control lights in hall, foyer, or other area that has windows and low ambient light requirement.	N	Areas too small
Daylight sensor, security	Install daylight sensor to control security light(s) in area that has windows.	N	Resource too small

TABLE 1.1. (contd)

<u>ERO Name</u>	<u>ERO Description</u>	<u>Evaluated (Y/N)</u>	<u>Comment</u>
Night setback	Install time clock to schedule fan, thermostat set point, and air-conditioner operation.	Y	
CO ₂ sensor control	Install CO ₂ sensor to control air-handler and ventilation fans.	Y	
Countdown timer	Install countdown timer to control air-handler and ventilation fans during normally unoccupied hours; typical scheme allows up to 2 hours fan operation, then has to be set again if occupant is still present.	Y	
Occupied mode via EMCS	Implement unoccupied schedules for fans and air-conditioning via EMCS; override during normally unoccupied hours by, e.g., phoned-in code.	Y	
<u>ELECTRIC DEMAND CONTROL</u>			
Water heater control	Install controls to shed electric water heater loads in rotating blocks during peak demand periods.	N	Few units at site
Shed A/C loads	Install controls to shed air-conditioning loads in rotating blocks during peak demand periods.	Y	
Well pump control	Transfer lift station and well pumps to emergency generators during peak.	N	Insufficient data
Run motors at low speed	Install controls to operate existing variable speed pumps and fans at low speed during peak demand periods.	Y	
Peak shave generator loads	Install controls to automatically transfer existing diesel generator loads to generator power during peak demand periods.	N	Loads tolerant to frequent switchover are small
Feed grid from generators	Install controls and switches to feed existing generator output to grid; operate during high demand periods to reduce peak demand.	Y	
<u>DOMESTIC WATER HEATING</u>			
Efficient heater	Replace water heater with high-efficiency (well-insulated) model.	Y	
Tank insulation	Add insulating blanket to provide additional tank insulation.	N	Already wrapped
Tankless heater	Replace tank type water heaters with instant/tankless unit.	N	Not applicable
Low-flow shower heads	Low-flow shower head restricts the volume of water passing through.	N	Not applicable

TABLE 1.1. (contd)

ERO Name	ERO Description	Evaluated (Y/N)	Comment
Lower hot water temperature	Reduced water temperature reduces energy lost in various hot water-consuming processes including showers, dishwashers, laundries, etc.	N	No specific application identified during site assessment
Insulate service hot water pipes	Typically, service hot water pipes are copper. Insulation is usually 1/2-inch glass fiber, and the temperature of the water is usually 140 °F. ASHRAE standard 90 A covers the insulation requirements on service hot water pipes.	Y	
Fuel switch to electric	Fuel switch from thermal loop to electric water heater.	N	Switch to natural gas more attractive
Fuel switch from electric	Install boiler or sidearm unit to switch from electric to natural gas or oil water heating.	N	Too few units
A/C desuperheater	Recover heat from air-conditioner by installing water-cooled desuperheater and controls.	N	Too few units
Refrigeration desuperheater	Recover heat from refrigerators by installing water-cooled desuperheater and controls.	N	Too few units
<u>TRANSMISSION & DISTRIBUTION</u>			
Phase balance	Improve phase balance of feeders and main transformers by moving loads among phases.	N	Phase balance is satisfactory
Efficient transformers	Replace transformers with high-efficiency models and reduce size when appropriate.	Y	
Reduce transformer size	Reduce transformer size to match load, thus reducing standby loss and reactive power.	N	Insufficient data
Baseload transformer	Add smaller high-efficiency baseload transformer and automatic switching equipment to switch out existing substation transformer except under heavy load.	N	Insufficient experience with ERO
Conservation voltage reduction	Reduce set point on auto-tap-changing transformer to just maintain minimum acceptable voltage at end of worst-case feeder.	Y	
CVR with remote sensing	Add voltage transducers at end of worst-case feeder(s) to control voltage more accurately to minimum acceptable level.	N	Voltage drops are too low to justify evaluation
Passive power factor correction	Install capacitor banks to provide passive power factor correction.	N	Reconsider after lighting & motor retrofits

TABLE 1.1. (contd)

<u>ERO Name</u>	<u>ERO Description</u>	<u>Evaluated (Y/N)</u>	<u>Comment</u>
Switched power factor correction	Install capacitor banks, power factor transducers and automatic switches to provide active power factor correction.	N	Reconsider after lighting & motor retrofits
<u>RESIDENTIAL HVAC</u>			
Whole house fan	Install whole house fans to reduce or eliminate the use of window air-conditioning.	Y	
Efficient furnace motor	Replace furnace fan motor with high-efficiency motor.	N	Insufficient data
2-speed furnace motor	Replace furnace fan motor with 2-speed motor.	N	Insufficient data
Ventilation heat recovery	Install air-to-air heat exchanger to reduce infiltration and recover heat from ventilation air.	N	Insufficient data
Efficient air-conditioner	Replace air-conditioner with high-efficiency unit.	N	No existing central air units
Efficient heat pump	Replace heat pump with high-efficiency unit.	N	No existing units
Heat pump	Replace electric resistance heat with heat pump.	N	No existing units
Fuel switch	Switch from electric heat to natural gas or oil by installing fuel burning furnace or I.C. engine-driven heat pump.	N	Not applicable
<u>RESIDENTIAL APPLIANCES</u>			
Efficient washer	Replace clothes washer with high-efficiency (water miser) unit.	N	Tenant-owned
Efficient dryer	Replace clothes dryer with high-efficiency unit.	N	Tenant-owned
Efficient dishwasher	Replace dishwasher with high-efficiency (water miser) dishwasher.	N	Technology in flux
Microwave oven	Provide microwave oven to reduce use of convection oven.	N	Insufficient data on cooking end use
<u>FREEZE PROTECTION BY HEAT TAPE</u>			
Thermostat	Provide thermostatic control (especially water storage tanks) of resistance heaters to eliminate continuous operation.	Y	
Insulate	Add insulation to pipes and tanks that have thermostatically controlled resistance heaters.	N	Temperature set point too low

TABLE 1.1. (contd)

<u>ERO Name</u>	<u>ERO Description</u>	<u>Evaluated (Y/N)</u>	<u>Comment</u>
<u>BOILERS</u>			
Preheat combustion air	A gas-to-air heat exchanger, or a heat pipe, used for transferring heat of exhaust gases to the primary combustion air.	N	Not applicable
Feedwater economizer	A gas-to-water heat exchanger consisting of feedwater tubes located in the path of the exhaust stream. Economizer can also be employed to heat domestic hot water, space heating water, or process hot water.	N	Not applicable
Air atomizing burner	Proper atomization of fuel oil is critical to ensure complete combustion with minimum excess air. Air-atomizing burners use steam or air for atomization, minimizing excess air and unburnt combustibles, and improving boiler efficiency.	N	Not applicable
Boiler tune-up	A tune-up is simple, can be generally accomplished within a day, and basically involves adjusting fuel-air ratios at optimal levels at various load conditions.	Y	Only conservation measure evaluated that pertains to oil-fired boilers
Flue gas analyzer	A combination of flue gas analyzers and regular tuning can assist in maintaining optimal boiler efficiency. A typical analyzer will monitor O ₂ , CO ₂ , CO, and exhaust temperature.	N	Not applicable
Barometric damper	Installing an automatic damper will reduce the standby loss in a boiler or a furnace. When the burner is off, the damper closes to minimize heat loss through the stack.	N	Not applicable
Automatic electric damper	Installing an automatic damper will reduce the standby loss in a boiler or a furnace. When the burner is off, the damper closes to minimize heat loss through the stack.	Y	Included as standard feature in replacement furnaces and H ₂ O heaters
Outside/supply air temperature reset controller	Install controller to reset the steam or hot water supply temperature based on a predetermined schedule. Operating at lower temperature reduces heat (and leaking steam) losses.	Y	New Post
New efficient boiler	When the refurbishment cost of an existing boiler is uneconomical, boiler replacement may be considered.	Y	Old Post ERO
Pulse or condensing boiler	Pulse or condensing boilers have an instantaneous efficiency of over 90%, and a seasonal efficiency that is 8% points higher than conventional units.	Y	Old Post ERO

TABLE 1.1. (contd)

<u>ERO Name</u>	<u>ERO Description</u>	<u>Evaluated (Y/N)</u>	<u>Comment</u>
Fire-tube turbulators	Turbulators improve overall combustion efficiency in fire-tube boilers. Efficiency increases due to better heat transfer and lower stack temperature.	N	Not applicable
Automatic boiler-blow-down system with heat recovery	Controlled boiler-blow down has the potential to reduce the blow-down losses. The continuous blow-down system senses the TDS level and controls blow-down rate.	N	Not applicable
O ₂ trim control	O ₂ Trim controls assist in maintaining low excess air levels by continuously monitoring O ₂ in the stack and adjusting the dampers accordingly.	N	Not applicable
<u>BOILER AUXILIARIES & DISTRIBUTION</u>			
Periodic inspection of steam traps	Steam traps need to be inspected at least once a year. The inspection program would 1) identify the types, location and number of various steam traps, 2) maintain some spare parts and spare traps of each kind, and 3) repair and replace traps on a routine basis.	N	Not applicable
Pipe insulation	Insulation could be applied to all hot and cold pipes which are either uninsulated, or whose insulation is deteriorated and is currently ineffective.	Y	Repair of pipe insulation on HTHW loop
Heating of fuel oil	Depending on the viscosity of fuel oil at ambient temperature, oil may need to be heated.	N	Not applicable
Insulate hot fuel-oil pipes	Lines leading the fuel oil from the heater to the burner may be insulated to (i) minimize energy loss, and (ii) ensure that the oil viscosity is maintained within acceptable limits at the burner.	N	Not applicable
Provide maintenance of economizers	Both gas-side and water-side deposits can reduce the effectiveness of the heat transfer surfaces. Periodic cleaning of the economizer will assist in maintaining high heat-recovery efficiencies.	N	Not applicable
Repair leaking HTHW or steam lines	Leaking HTHW or steam lines are a major source of energy loss. The leak rate in lb/h is a function of the steam (HTHW) pressure and diameter and shape of the orifice through which it leaks.	Y	Repair of pipe insulation and leaks in HTHW loop
Heat recovery heat exchanger	Various forms of waste heat can be recovered through appropriately sized heat exchanger systems.	N	Not applicable

TABLE 1.1. (contd)

<u>ERO Name</u>	<u>ERO Description</u>	<u>Evaluated (Y/N)</u>	<u>Comment</u>
Insulate condensate storage tanks	Tanks need to be insulated to prevent heat loss. Since condensate tank temperatures can be as high as 180 °F, proper insulation is critical for minimizing heat loss.	N	Not applicable
VSD feedwater pump	Install variable-speed drive to feedwater pump controlled by steam drum water level.	N	Too few units at site
VSD combustion fan	Install variable-speed drives for combustion air and stack fans controlled by firing rate and static pressure at firebox.	N	Too few units at site
Check valves	Repair leaking condensate return check valves.	N	Too few units at site
<u>CHILLERS</u>			
Repair check valves	Repair leaking check valves in lead-lag pumps.	N	Light cooling loads/few units
Condenser water reset	Add controls to reset condenser water temperature on outdoor temperature.	N	Light cooling loads/few units
Chilled water reset	Add controls to reset chilled water temperature on chiller load.	N	Light cooling loads/few units
Parallel compressors	Add smaller, efficient compressor to obtain efficient operation under light-to-moderate load.	N	Light cooling loads/few units
Efficient chiller	Replace chiller with high-efficiency unit.	N	Light cooling loads/few units
<u>PACKAGE HVAC (including split units)</u>			
Expansion valve control	Install improved expansion valve control; Replace capillary tube if necessary.	N	Light cooling loads/few units
Improve liquid return	Replace liquid return with larger line or install pump ("liquid pressure amplification").	N	addressed by ECIP proj w/existing NIMO rebate
Parallel compressors	Add smaller, efficient compressor to obtain efficient operation under light-to-moderate load.	N	Light cooling loads/few units
Efficient new unit	Replace package or split unit with high-efficiency unit.	N	Light cooling loads/few units
Precooling/reheating heat pipe for latent load	Install heat pipe to reduce coil load while maintaining latent capacity by precooling mixed air and reheating supply air.	N	Light cooling loads/few units

TABLE 1.1. (contd)

<u>ERO Name</u>	<u>ERO Description</u>	<u>Evaluated (Y/N)</u>	<u>Comment</u>
<u>SWIMMING POOLS</u>			
Direct fired make-up air	Install direct-fired make-up air heater in air-supported pool enclosures.	N	No application at site
Heat pump dehumidification	Install dehumidifying heat pump to reduce ventilation load of enclosed pool.	N	Insufficient data
<u>ENVELOPE</u>			
Insulate ceilings	Batt-type fiberglass insulation and blown-in fiberglass or cellulose are most frequently used as ceiling insulation.	Y	Blown-in fiberglass Old Post and all-electric housing
Insulate walls	Insulate with rigid, non-rigid, poured-in, or blown-in insulation. For a wood frame wall or a cavity wall, remove top strip of siding or drill holes in sheathing or inside gyp-board and completely fill each stud space with blown-in insulation.	N	Walls already insulated or inaccessible
Insulate slab-on-grade perimeter	To insulate the slab, it will be necessary to dig around the building up to the depth of the frost line or the footing, whichever is shallower.	N	Not applicable
Insulate floor above crawl space	Fiberglass batt or blanket insulation is ideally suited for insulating floors above crawl spaces. Typically, the insulation is hung using a wire mesh, nails, and staples. Vapor barrier is installed against the floor surface prior to installation of the insulation.	Y	Selected Old Post buildings
Storm windows/doors and multi-glazed windows	Storm windows create a "dead-air" space for insulation and also reduce infiltration. Multi-glazed windows replace existing windows.	N	Virtually all windows on the post are either double-glazed or have storm windows
Movable Window Insulation	Install insulated roller-shade with edge seals in all large windows.	Y	
Tinted/reflective window film or screen	Window tinting or micro-louver screens can be applied to an existing window to reduce solar heat gain.	N	Not applicable
Insulate supply and return ducts	Add fiberglass insulation to supply and return ducts.	N	Not applicable
Weatherstripping	Install weatherstripping to door and window perimeters to provide a tight seal limiting or eliminating infiltration.	Y	Old Post WWII buildings
Caulking	A bead of caulk should be applied to seams in building structures where air can infiltrate.	Y	On- and off-post housing
<u>SPACE HEATING</u>			
Install new energy-efficient furnace	Replacement is cost effective if existing furnaces are very old and inefficient.	Y	Old Post all furnaces

TABLE 1.1. (contd)

<u>ERO Name</u>	<u>ERO Description</u>	<u>Evaluated (Y/N)</u>	<u>Comment</u>
Infrared heaters	Provide spot or space heating by overhead infrared heating system to provide comfort with lower air temperature and corresponding lower envelope conduction and infiltration loss; also reduces energy used to power fans and pumps.	N	Not applicable
Space unit heaters	Replace old space heater with a new space heater.	N	Not applicable
Electric baseboard heaters	Baseboard unit provides more uniform heating due to placement at base of exterior walls where heat loss occurs.	N	Not applicable
Install programmable thermostat with setback controls	Electronic thermostats provide the means to set back temperature when the space is unoccupied or a greater deviation from normal set point temperature can be tolerated.	Y	Old Post

2.0 ENERGY RESOURCE OPPORTUNITY EVALUATIONS

The results of the analyses of EROs are presented within 14 common energy end-use categories. A narrative description of each ERO is provided, including information on the initial cost, energy and dollar savings, impacts on operations and maintenance and, when applicable, a discussion of energy supply and demand, energy security, and environmental issues. A brief description of the evaluation methodologies and technical and cost assumptions is also included. A more detailed description of the methodology for estimating field performance and efficiency improvement of EROs and the approach for estimating life-cycle costs will be documented as part of this program.

At the end of each section, a summary table presents the operational performance of energy end-use equipment before and after the implementation of each ERO. The summary tables also provide the results of the life-cycle cost analysis, including the net present value (NPV) and value index (VI) of each ERO.

Analysis results are presented in four categories representative of Fort Drum: New Post, Old Post, on-post family housing, and off-post family housing. Savings are indicated by fuel type: fuel oil #2 (FO2), natural gas (NG), high-temperature hot water (HTHW), propane, and electricity.

Individual EROs were evaluated as mutually exclusive measures (with the exception of occupancy sensors, a measure that was evaluated with both current and recommended lighting configurations). This approach allows individual EROs to be ranked or rated based on parameters such as initial cost, NPV, energy savings, and changes in operations and management (O&M) requirements. In addition, this evaluation approach permits direct economic comparison of competing EROs (e.g., energy-efficient furnace versus condensing furnace).

2.1 SAGE COMPLEX

The Sage Complex consists of five buildings located off-post near Syracuse, New York. Numerous previous energy and engineering studies have been performed to evaluate the energy resource opportunities at this facility. In particular, a Tennessee Valley Authority (TVA) study indicates that much of the existing mechanical and electrical equipment has exceeded its service life according to ASHRAE standards and should be replaced with new high-efficiency equipment, sized to meet the current and projected building requirements.

The modernization projects identified include the following:

- Convert HVAC system to smaller size.
- Change air-handling system to variable-volume type.
- Convert heating system from steam to hot water and from using fuel oil #2 to natural gas.
- Abandon existing pneumatic controls and use electronic controls.
- Use downflow/upflow area air-conditioning systems in computer room.
- Change electrical equipment to accommodate new HVAC systems.
- Replace existing lighting with more efficient lighting.
- Install new diesel generators.

The TVA study estimated the total project cost at approximately \$2 million, with annual energy savings of \$500,000 and annual maintenance savings of \$150,000. Electrical savings have been estimated at 7,000,000 kWh/yr.

These above-mentioned recommendations were made several years ago. Currently, the Sage Complex is installing new natural gas-fired steam boilers and new centrifugal chillers. According to the previous studies, the existing steam and chilled water distribution systems should also be replaced. These distribution system projects, not included in the current construction project, remain valid.

In addition to the boiler and chiller replacement project, Sage is currently performing several in-house lighting projects oriented toward energy conservation. However, many good lighting projects still exist.

It is recommended that the Sage Complex be included as a constituent of any forthcoming integrated energy resource acquisition proposals.

2.2 BOILER AND FURNACE EROs

Converting existing oil-fired boilers and furnaces on the Old Post to natural gas-fired units is of primary concern to Fort Drum, and therefore was the primary focus of this section. There are approximately 600 oil-fired furnaces and 150 oil-fired boilers in commercial buildings on the Old Post. Many of these units are under 10 years old, installed under the umbrella of two major renovation projects. Most of the rest are much older, some nearing the end of their useful lives.

At the beginning of this project, Fort Drum supplied PNL with a *Heating Equipment Summary List* of furnaces and boilers on the Old Post. The list established two action divisions for the furnaces and boilers:

- Replace older furnaces/boilers with new natural gas-fired boilers.
- Convert burners of newer furnaces/boilers by removing the existing oil-fired burner assembly and replacing it with a new natural gas-fired burner assembly.

For furnace/boiler replacement, two alternatives were considered: high-efficiency natural gas-fired units (annual fuel utilization percent efficiency [AFUE] in the 80 to 85% range), and very high-efficiency condensing or "pulse" natural gas-fired units (AFUE above 90%).

During the course of this analysis, PNL uncovered potential technical concerns and limitations associated with converting burners, especially in furnaces. Because of the potential problems and limitations associated with converting furnace/boiler burners, PNL has also evaluated the effectiveness of replacing all the furnaces and boilers on the Old Post, regardless of age.

In addition to the EROs pertaining to fuel-switching, the resource opportunity of boiler tune-up was evaluated for existing oil-fired boilers.

Approximately 15 buildings on the Old Post have steam boilers with aging steam heat distribution systems. It is recommended that, upon conversion of the Old Post from fuel oil to natural gas, consideration should be given to replacing the steam boiler and distribution system with a hydronic boiler/distribution system. Hydronic heating systems typically require less maintenance than steam systems and are more efficient, due in large part to the

ability to reset boiler water temperature based on outside air temperature. A complete economic analysis of this alternative was beyond the scope of this study; however, all the steam boilers in these buildings are included in the natural gas conversion EROs presented in the following subsections.

All the measures associated with converting from natural gas to fuel oil have similar or identical impacts in the areas of energy security and environmental protection. These impacts are summarized below for EROs 2.2.1 through 2.2.10.

- Energy Security. Most buildings on the Old Post have a dedicated underground tank. Currently, fuel oil tanks are refilled about once a month. Although the price of fuel oil has fluctuated significantly, supply has not been disrupted to date (with the potential exception of a contractor missed refill).

Natural gas would probably be delivered to the Old Post by one large distribution main. A break in this line or a supply disruption would result in a complete and immediate loss of space and water heating capability in all buildings unless a back-up system is installed.

- Environmental Issues. Environmental benefits that will accrue as a result of conversion to natural gas include the elimination of oil leaks and spills (upon removal of the storage tanks and piping) and a slight reduction in carbon monoxide and hydrocarbon particulate matter emissions into the air. Quantifying the economic benefits of these environmental improvements, however, is beyond the scope of this study.

2.2.1 Convert Oil-Fired Furnace Burners (in Newer Furnaces) to Natural Gas Burners

Description

There are approximately 400 furnaces on the Old Post that are under 10 years old. Because the furnaces are relatively new (the expected life of a furnace is 25 years) burner conversion was considered as an inexpensive alternative to replacing the entire furnace.

Discussions with an HVAC contractor familiar with Fort Drum furnaces raised a concern that not all of the furnaces are readily converted from fuel oil to natural gas. Fuel oil burns hotter than natural gas, particularly in newer units, such as some of those found at Fort Drum, with flame-retention

burners. The contractor indicated that some of these furnaces (those manufactured by Ducane) have a secondary heat exchange surface, or tubes, to extract more heat from exhaust gases after they pass through the primary heat exchanger. By converting the furnace burners to natural gas, the contractor speculated that it is possible that the secondary heat exchanger may lower the temperature of exhaust gases below the condensation point.

Ducane's manufacturer representative indicated that it is unlikely that flue gases, even with natural gas, would reach the condensation point in the secondary heat exchanger. However, the manufacturer did point out other potential problems and limitations associated with converting their oil-fired furnaces to natural gas. First, the combustion chambers of the larger (over 150,000 MBtu/h output) Ducane furnaces are stainless steel. The oil-fired burners distribute a flame across the chamber's surface. If a power gas burner were installed, producing a more focused flame, the stainless steel chamber might rapidly burn out.

A second limitation of converting to natural gas pertains to derating (downsizing) the natural gas burner. The manufacturer recommends that the burner should not be derated more than 10% relative to the existing burner rating. The existing heat-exchanger was designed to optimally transfer the heat produced by a fuel-oil burner of a specific size range; installing a smaller natural gas burner could result in relative cold spots in the heat exchanger. As a result, expansion and contraction problems could result in premature failure of the heat exchanger.

These technical concerns should be addressed prior to converting any existing fuel oil furnaces to natural gas.

Burner manufacturers have indicated that retrofitting new natural gas burners may increase the overall efficiency of the furnace by approximately 2% due the slightly higher efficiency of the replacement burner.

Assumptions

Technical assumptions are as follows:

- The existing furnaces were estimated to be operating at 70% efficiency. Their efficiency was improved by 2% through the retrofit burners.
- The reduction in energy use attributable to installing new retrofit burners is based on the difference in efficiencies between the existing and recommended equipment. The percent efficiency increase was projected onto the calculated energy usage for each building type to ascertain total savings.
- The total annual maintenance savings per furnace is \$55 per Fort Drum report. Oil-fired equipment receives annual servicing, which consumes an average of 3 hours per appliance; a natural gas appliance of similar average size would require approximately 1 hour annually. Maintenance labor costs \$20/h. Materials savings per appliance are one nozzle at \$5 and one oil strainer at \$10.
- Number of furnaces requiring burner conversion is 383 per the *Heating Equipment Summary List*.

Cost estimates are as follows:

	<u>Material</u>	<u>Labor</u>	<u>Total</u>
NG Service Line	\$130	\$300	\$430
NG Replacement Burner	\$960	\$600	<u>\$1,560</u>
Total Cost			\$1,950

- Average size furnace is 250,000 MBtu/h.
- Cost of conversion includes 40 linear feet of natural gas service line feeding from the main distribution line.
- Cost estimate includes 30% for overtime & profit (O&P) and contingencies.
- Material costs were obtained from manufacturer's representatives and labor costs from HVAC contractors.

Results

The complete quantitative results of this ERO appear in Table 2.1 (p. 2.27). The table contains specific energy, cost, and economic performance data. This ERO affects all buildings with furnaces under 10 years old on the Old Post, covering slightly over 1,350,000 ft² of commercial floor area.

Budget Implications. The estimated initial cost of the measure is \$746,850.

Energy and Cost Savings. It is estimated that this ERO will result in an annual energy savings of 2055 MBtu at a value of \$64,696.

Operations and Maintenance. Oil-fired furnaces require cleaning and replacing burner tips and orifices and performing operating adjustments to the atomizing pressure, fuel temperature, and burner position; natural gas furnaces do not. The annual maintenance savings resulting from this ERO is \$21,065.

2.2.2 Replace (Older) Oil-Fired Furnaces with Energy-Efficient Natural Gas Furnaces

Description

There are approximately 200 oil-fired furnaces on the Old Post that are more than 10 years old, many of which are approaching the end of their useful lives. New energy-efficient natural gas furnaces with intermittent ignition devices and electro-mechanical vent dampers were considered to replace existing low-efficiency oil-fired units. The models evaluated exceed the New York Energy Code, which requires a minimum annual fuel utilization efficiency (AFUE) of 78% for furnaces smaller than 225,000 MBtu/h.

Assumptions

Technical assumptions are as follows:

- Existing furnaces were estimated to be operating at 66% efficiency.
- New energy-efficient natural gas furnaces have an AFUE of 82%.
- The total maintenance savings per furnace is \$55 per Fort Drum report. Oil-fired equipment receives annual servicing, which consumes an average of 3 hours per appliance; a natural gas appliance of similar average size would require approximately 1 hour annually. Maintenance labor costs \$20/h. Materials savings per appliance: one nozzle at \$5 and one oil strainer at \$10.

Cost estimates are as follows:

	<u>Material</u>	<u>Labor</u>	<u>Total</u>
Furnace Removal	--	\$130	\$130
NG Service Line	\$130	\$300	\$430
Installed Furnace	\$1,500	\$400	<u>\$1,900</u>
Total			\$2,460

- Total number of furnaces to replace is 190. 85 furnaces have capacities <144,000 MBtu/h and 105 >144,000 MBtu/h.
- Estimated replacement furnace capacities were downsized to reflect current estimated peak and diurnal heat loss conditions at Fort Drum.
- Cost of replacement includes 40 linear feet of natural gas service line feeding from the main distribution line, removal of the existing furnace, and installation and hookup of new furnace.
- Cost estimate includes 30% for O&P and contingencies.
- Furnace removal costs were obtained from Means.^(a)
- Materials costs were obtained from manufacturer's representatives and labor costs from HVAC contractors and these estimates were verified with Means (1991).

Results

The complete quantitative results of this ERO appear in Table 2.1. The table contains specific energy, cost, and economic performance data. This ERO affects all buildings on the Old Post with furnaces older than 10 years, covering a total of slightly over 735,000 ft² of commercial floor area.

Budget Implications. The estimated initial cost of the measure is \$466,970.

Energy and Cost Savings. It is estimated that this ERO will result in an annual energy savings of 9,045 MBtu at a value of \$70,781.

Operations and Maintenance. Oil-fired furnaces require cleaning and replacing burner tips and orifices and performing operating adjustments to the

(a) Throughout this report Means refers to Means Mechanical Cost Data, Means Electrical Cost Data, and Means Construction Cost Data, 1991.

atomizing pressure, fuel temperature, and burner position (BEI 1991); natural gas furnaces do not. The maintenance savings resulting from this ERO is \$10,450.

2.2.3 Replace (Older) Oil-Fired Furnaces with Natural Gas-Condensing Furnaces

Description

There are approximately 200 oil-fired furnaces on the Old Post that are older than 10 years, many of which are approaching the end of their useful life. New condensing furnaces, which represent the current generation of furnaces, were analyzed to replace the aging units. Condensing furnaces typically use two or more heat-exchangers to extract the maximum heat from combustion gases, including latent heat, and have an AFUE of approximately 93%. Exhaust gas temperatures are between 120 and 130°F instead of the 400 to 500°F temperature associated with conventional furnaces. Because of the lower vent gas temperatures, PVC tubing is used for venting instead of typical metal vents. As the flue gases cool, moisture condenses out of them and is collected in a trap assembly, then routed to a standard floor drain.

Assumptions

Technical assumptions are as follows:

- Existing furnaces were estimated to be operating at 66% efficiency.
- New natural gas condensing furnaces have an AFUE of 93%.
- The total maintenance savings per furnace is \$55 per Fort Drum report. Oil-fired equipment receives annual servicing, which consumes an average of 3 hours per appliance; a natural gas appliance of similar average size would require approximately 1 hour annually. Maintenance labor costs \$20/h. Materials savings per appliance: one nozzle at \$5 and one oil strainer at \$10.

Cost estimates are as follows:

	<u>Material</u>	<u>Labor</u>	<u>Total</u>
Furnace Removal	--	\$130	\$130
NG Service Line	\$130	\$300	\$430
Installed Furnace	\$2,520	\$700	<u>\$3,220</u>
Total			\$3,780

- Total number of furnaces to replace is 190: 85 furnaces have capacities <144,000 MBtu/h and 105 >144,000 MBtu/h, according to the *Heating Equipment Summary List*.
- Estimated replacement furnace capacities were downsized to reflect current estimated peak and diurnal heat loss conditions at Fort Drum.
- Cost of replacement includes 40 linear feet of natural gas service line feeding from the main distribution line, removal of the old furnace, and hookup and installation of the new furnace.
- Cost estimate includes 30% for O&P and contingencies.
- Furnace removal costs were obtained from Means (1991).
- Materials costs were obtained from manufacturer's representatives and labor costs from HVAC contractors and estimates were verified with Means (1991).

Results

The complete quantitative results of this ERO appear in Table 2.1. The table contains specific energy, cost, and economic performance data. This ERO affects all buildings on the Old Post with furnaces older than 10 years, covering slightly over 735,000 ft² in commercial floor area.

Budget Implications. The estimated initial cost of the measure is \$718,570.

Energy and Cost Savings. It is estimated that this ERO will result in an annual energy savings of 15,368 MBtu at a value of \$98,884.

Operations and Maintenance. Oil-fired furnaces require cleaning and replacing burner tips and orifices and performing operating adjustments to the atomizing pressure, fuel temperature, and burner position; natural gas furnaces do not. The maintenance savings resulting from this ERO is \$10,450.

2.2.4 Replace (All) Oil-Fired Furnaces with Energy-Efficient Natural Gas Furnaces

Description

Because of some of the potential difficulties and limitations associated with converting oil-fired furnaces to natural gas, an evaluation was performed

on replacing all the existing oil-fired furnaces on the Old Post with new energy-efficient natural gas-fired units.

The majority of furnaces at Fort Drum are oversized; in practice, oversized HVAC systems tend to overheat and over-pressurize the living space leading to occupancy discomfort. By converting only the burner, an opportunity is missed to significantly downsize the furnace. An appropriately sized furnace results in increased occupancy comfort and reduced energy consumption by economy of scale.

Assumptions

Technical assumptions are as follows:

- Existing newer furnaces were estimated to be operating at 70% efficiency and older furnaces at 66%.
- New energy-efficient natural gas furnaces have an AFUE of 82%.
- The total maintenance savings per furnace is \$55 per Fort Drum report. Oil-fired equipment receives annual servicing, which consumes an average of 3 hours per appliance; a natural gas appliance of similar average size would require approximately 1 hour annually. Maintenance labor costs \$20/h. Materials savings per appliance: one nozzle at \$5 and one oil strainer at \$10.

Cost estimates are as follows:

	<u>Material</u>	<u>Labor</u>	<u>Total</u>
Furnace Removal	--	\$130	\$130
NG Service Line	\$130	\$300	\$430
Installed Furnace	\$1500	\$400	<u>\$1,900</u>
Total			\$2,460

- Total number of furnaces to replace is 573, according to the *Heating Equipment Summary List*.
- Estimated replacement furnace capacities were downsized to reflect current estimated peak and diurnal heat loss conditions at Fort Drum.
- Cost of replacement includes 40 linear feet of natural gas service line feeding from the main distribution line, removal of the old furnace, and installation and hookup of the new furnace.
- Cost estimate includes 30% for O&P and contingencies.

- Furnace removal costs were obtained from Means (1991).
- Materials costs were obtained from manufacturer's representatives and labor costs from HVAC contractors and these estimates were verified with Means (1991).

Results

The complete quantitative results of this ERO appear in Table 2.1. The table contains specific energy, cost, and economic performance data. This ERO affects all buildings on the Old Post with furnaces, covering a total of slightly over 2 million square feet of commercial floorspace.

Budget Implications. The estimated initial cost of the measure is \$1,390,170.

Energy and Cost Savings. It is estimated that this ERO will result in an annual energy savings of 16,236 MBtu at a value of \$158,322.

Operations and Maintenance. Oil-fired furnaces require cleaning and replacing burner tips and orifices and performing operating adjustments to the atomizing pressure, fuel temperature, and burner position; natural gas furnaces do not. The maintenance savings resulting from this ERO is \$31,515.

2.2.5 Replace All Oil-Fired Furnaces with Natural Gas Condensing Furnaces

Description

Because of some of the difficulties and limitations associated with converting oil-fired furnaces to natural gas, an evaluation was performed on replacing all the existing furnaces on the Old Post with new condensing natural gas-fired units.

Assumptions

Technical assumptions are as follows:

- Existing newer furnaces were estimated to be operating at 70% efficiency and older furnaces at 66%.
- New natural gas condensing furnaces have an AFUE of 93%.
- The total maintenance savings per furnace is \$55 per Fort Drum report. Oil-fired equipment receives annual servicing, which consumes an average of 3 hours per appliance; a natural gas

appliance of similar average size would require approximately 1 hour annually. Maintenance labor costs \$20/h. Materials savings per appliance: one nozzle at \$5 and one oil strainer at \$10.

Cost estimates are as follows:

	<u>Material</u>	<u>Labor</u>	<u>Total</u>
Furnace Removal	--	\$130	\$130
NG Service Line	\$130	\$300	\$430
Installed Furnace	\$2,570	\$700	<u>\$3,270</u>
Total			\$3,830

- Total number of furnaces to replace is 573, according to the *Heating Equipment Summary List*.
- Estimated replacement furnace capacities were downsized to reflect current estimated peak and diurnal heat loss conditions at Fort Drum.
- Cost of replacement includes 40 linear feet of natural gas service line feeding from the main distribution line(2), removal of the old furnace, and installation and hookup of the new furnace.
- Cost estimate includes 30% for O&P and contingencies.
- Furnace removal costs were obtained from Means (1991).
- Materials costs were obtained from manufacturer's representatives, and labor costs from HVAC contractors; verbal estimates were verified with Means (1991).

Results

The complete quantitative results of this ERO appear in Table 2.1. The table contains specific energy, cost, and economic performance data. This ERO affects all buildings on the Old Post with furnaces, covering a total of slightly over two million square feet of commercial floorspace.

Budget Implications. The estimated initial cost of the measure is \$2,196,070.

Energy and Cost Savings. It is estimated that this ERO will result in an annual energy savings of 33,859 MBtu at a value of \$236,394.

Operations and Maintenance. Oil-fired furnaces require cleaning and replacing burner tips and orifices and performing operating adjustments to the

atomizing pressure, fuel temperature, and burner position; natural gas furnaces do not. The maintenance savings resulting from this ERO is \$31,515.

2.2.6 Convert Oil-Fired Boiler Burners (on Newer Boilers) to Natural Gas Burners

Description

There are approximately 85 boilers on the Old Post that are less than 10 years old. The option of converting only the burner and related assemblies was considered to save costs compared with replacing the entire boiler.

Converting boilers from fuel oil to natural gas-fired is relatively straightforward. Modular natural gas burners, manufactured to directly replace oil-fired units, can be installed relatively easily. The boilers at Fort Drum are the "wet-based" type, which tend to accumulate soot on their heat exchange surfaces. Converting to natural gas, a cleaner fuel, will result in less soot buildup and therefore an increase in thermal efficiency. Burner manufacturers claim that an efficiency improvement of approximately three percent is possible when converting boiler burners from oil-fired to natural gas. As with furnace burner conversions there are limitations to derating the burner when converting boilers to natural gas. The rule of thumb is not to downsize more than 20%.

Assumptions

Technical assumptions are as follows:

- Existing newer boilers were estimated to be operating at 75%.
- Conversion increases boiler efficiency by 3%.
- The total maintenance savings per furnace is \$55 per Fort Drum report. Oil-fired equipment receives annual servicing, which consumes an average of 3 hours per appliance; a natural gas appliance of similar average size would require approximately 1 hour annually. Maintenance labor costs \$20/h. Materials savings per appliance: one nozzle at \$5 and one oil strainer at \$10.

Cost estimates are as follows:

	<u>Material</u>	<u>Labor</u>	<u>Total</u>
NG Service Line	\$130	\$300	\$430
NG Replacement Burner	\$3,105	\$600	<u>\$3,705</u>
Total			\$4,135

- Average boiler capacity is 400 MBtu/h.
- There are 84 boilers to convert, according to the *Heating Equipment Summary List*.
- Cost of conversion includes 40 linear feet of natural gas service line feeding from the main distribution line, removal of the old furnace, and hookup and installation of the new furnace.
- Cost of conversion includes replacing the fuel oil barometric damper with a barometric damper compatible with natural gas burners.
- Cost estimate includes 30% for O&P and contingencies.
- Materials costs were obtained from manufacturer's representatives and labor costs from HVAC contractors.

Results

The complete quantitative results of this ERO appear in Table 2.1. The table contains specific energy, cost, and economic performance data. This ERO affects buildings on the Old Post with boilers under 10 years old, covering a total of slightly over 785,000 ft² of commercial floorspace.

Budget Implications. The estimated initial cost of the measure is \$347,275.

Energy and Cost Savings. It is estimated that this ERO will result in an annual energy savings of 1966 MBtu at a value of \$44,181.

Operations and Maintenance. Oil-fired furnaces require cleaning and replacing burner tips and orifices and performing operating adjustments to the atomizing pressure, fuel temperature, and burner position; natural gas boilers do not. The maintenance savings resulting from this ERO is \$4,620.

2.2.7 Replace Oil-Fired Boilers with Efficient Natural Gas Boilers

Description

There are over 60 oil-fired boilers on the Old Post that are approaching the end of their useful lives. An evaluation was performed to determine the cost-effectiveness of replacing these boilers with energy efficient boilers characterized by intermittent ignition devices and electronic flue dampers.

Assumptions

Technical assumptions are as follows:

- Existing older boilers were estimated to be operating at 68%.
- New natural gas energy efficient boilers have an AFUE of 83%.
- The total maintenance savings per furnace is \$55 per Fort Drum report. Oil-fired equipment receives annual servicing, which consumes an average of 3 hours per appliance; a natural gas appliance of similar average size would require approximately 1 hour annually. Maintenance labor costs \$20/h. Materials savings per appliance: one nozzle at \$5 and one oil strainer at \$10.

Cost estimates are as follows:

	<u>Material</u>	<u>Labor</u>	<u>Total</u>
Boiler Removal	--	\$290	\$290
NG Service Line	\$130	\$300	\$430
Installed Boiler	\$3,540	\$1,500	<u>\$5,040</u>
Total			\$5,760

- Total number of boilers to replace is 63, according to the *Heating Equipment Summary List*.
- Average boiler capacity is 360 MBH.
- Estimated replacement boilers capacities were downsized to reflect current estimated peak and diurnal heat loss conditions at Fort Drum.
- Cost of furnace replacement includes 40 linear feet of natural gas service line feeding from the main distribution line, removal of the old boiler, and installation and of the new boiler.

- Cost of replacement boiler includes replacing the fuel oil barometric damper with a barometric damper compatible with natural gas burners.
- Cost estimates include 30% for O&P and contingencies.
- Boiler removal costs were obtained from Means (1991).
- Materials costs were obtained from manufacturer's representatives and labor costs from HVAC contractors, and these estimates were verified with Means (1991).

Results

The complete quantitative results of this ERO appear in Table 2.1. The table contains specific energy, cost, and economic performance data. This ERO affects buildings on the Old Post with boilers over 10 years old, covering a total of slightly under 370,000 ft² of commercial floorspace.

Budget Implications. The estimated initial cost of the measure is \$362,880.

Energy and Cost Savings. It is estimated that this ERO will result in an annual energy savings of 3,964 MBtu at a value of \$34,900.

Operations and Maintenance. Oil-fired furnaces require cleaning and replacing burner tips and orifices and performing operating adjustments to the atomizing pressure, fuel temperature, and burner position; natural gas boilers do not. The maintenance savings resulting from this ERO is \$3,465.

2.2.8 Replace (Older) Oil-Fired Boilers with Natural Gas Condensing Boilers

Description

There are over 60 oil-fired boilers on the Old Post that are approaching the end of their useful lives. An evaluation was performed to determine the cost-effectiveness of replacing these boilers with natural gas-fired condensing boilers that represent the current generation of very high-efficiency boilers.

Assumptions

Technical assumptions are as follows:

- Existing older boilers were estimated to be operating at 68%.

- New natural gas condensing boilers have an AFUE of 90%.
- Cost of replacement includes 40 linear feet of natural gas service line feeding from the main distribution line, removal of the old furnace, and hookup and installation of the new furnace.
- The total maintenance savings per furnace is \$55 per Fort Drum report. Oil-fired equipment receives annual servicing, which consumes an average of 3 hours per appliance; a natural gas appliance of similar average size would require approximately 1 hour annually. Maintenance labor costs \$20/h. Materials savings per appliance: one nozzle at \$5 and one oil strainer at \$10.

Cost estimates are as follows:

	<u>Material</u>	<u>Labor</u>	<u>Total</u>
Boiler Removal	--	\$290	\$290
NG Service Line	\$130	\$300	\$430
Installed Boiler	\$4,860	\$2,000	<u>\$6,860</u>
Total			\$7,580

- Total number of boilers to replace is 63, according to the *Heating Equipment Summary List*.
- Average boiler capacity is 360 MBH.
- Estimated replacement boilers capacities were downsized to reflect current estimated peak and diurnal heat loss conditions at Fort Drum.
- Cost of conversion includes replacing the fuel oil barometric damper with a barometric damper compatible with natural gas burners.
- Cost estimate includes 30% for O&P and contingencies.
- Boiler removal costs were obtained from Means (1991).
- Materials costs were obtained from manufacturer's representatives and labor costs from HVAC contractors, and these estimates were verified with Means (1991).

Results

The complete quantitative results of this ERO appear in Table 2.1. The table contains specific energy, cost, and economic performance data. This ERO

affects buildings on the Old Post with boilers over 10 years old, covering slightly under 370,000 ft² of commercial floorspace.

Budget Implications. The estimated initial cost of the measure is \$477,540.

Energy and Cost Savings. It is estimated that this ERO will result in an annual energy savings of 6,580 MBtu at a value of \$46,491.

Operations and Maintenance. Oil-fired furnaces require cleaning and replacing burner tips and orifices and performing operating adjustments to the atomizing pressure, fuel temperature, and burner position; natural gas boilers do not. The maintenance savings resulting from this ERO is \$3,465.

2.2.9 Replace All Oil-Fired Boilers with Energy-Efficient Natural Gas Boilers

Description

Because of limitations associated with converting oil-fired boilers to natural gas, an evaluation was performed on replacing all the existing boilers on the Old Post with new energy-efficient natural gas-fired units.

Assumptions

Technical assumptions are as follows:

- Existing boilers under 10 years old were estimated to be operating at 75% and older boilers at 68%.
- New natural gas energy-efficient boilers have an AFUE of 83%.
- The total maintenance savings per furnace is \$55 per Fort Drum report. Oil-fired equipment receives annual servicing, which consumes an average of 3 hours per appliance; a natural gas appliance of similar average size would require approximately 1 hour annually. Maintenance labor costs \$20/h. Materials savings per appliance: one nozzle at \$5 and one oil strainer at \$10.

Cost estimates are as follows:

	<u>Material</u>	<u>Labor</u>	<u>Total</u>
Boiler Removal	--	\$290	\$290
NG Service Line	\$130	\$300	\$430
Installed Boiler	\$3,540	\$1,500	\$5,040
Total			\$5,760

- Total number of boilers to replace is 147.
- Average boiler capacity is 360 to 400 MBH.
- Estimated replacement boilers capacities were downsized to reflect current estimated peak and diurnal heat loss conditions at Fort Drum.
- Cost of furnace replacement includes 40 linear feet of natural gas service line feeding from the main distribution line, removal of the old boiler, and installation hookup of the new boiler.
- Cost of replacement boiler includes replacing the fuel oil barometric damper with a barometric damper compatible with natural gas burners.
- Cost estimates include 30% for O&P and contingencies.
- Boiler removal costs were obtained from Means (1991).
- Materials costs were obtained from manufacturer's representatives and labor costs from HVAC contractors; these estimates were verified with Means (1991).

Results

The complete quantitative results of this ERO appear in Table 2.1. The table contains specific energy, cost, and economic performance data. This ERO affects all buildings on the Old Post with oil-fired boilers covering a total of slightly over 1,150,000 ft² of commercial floorspace.

Budget Implications. The estimated initial cost of the measure is \$846,720.

Energy and Cost Savings. It is estimated that this ERO will result in an annual energy savings of 7,896 MBtu at a value of \$88,792.

Operations and Maintenance. Oil-fired furnaces require cleaning and replacing burner tips and orifices and performing operating adjustments to the atomizing pressure, fuel temperature, and burner position; natural gas boilers do not. The maintenance savings resulting from this ERO is \$8,085.

2.2.10 Replace All Oil-Fired Boilers with Natural Gas Condensing Boilers

Description

Because of limitations associated with converting oil-fired boilers to natural gas, an evaluation was performed on replacing all the existing boilers on the Old Post with new condensing natural gas-fired units.

Assumptions

Technical assumptions are as follows:

- Existing boilers under 10 years old were estimated to be operating at 75% and older boilers at 68%.
- New natural gas condensing boilers have an AFUE of 90%.
- Cost of replacement includes 40 linear feet of natural gas service line feeding from the main distribution line, removal of the old furnace and hookup and installation of the new furnace.
- The total maintenance savings per furnace is \$55 per Fort Drum report. Oil-fired equipment receives annual servicing, which consumes an average of 3 hours per appliance; a natural gas appliance of similar average size would require approximately 1 hour annually. Maintenance labor costs \$20/h. Materials savings per appliance: one nozzle at \$5 and one oil strainer at \$10.

Cost estimates are as follows:

	<u>Material</u>	<u>Labor</u>	<u>Total</u>
Boiler Removal	--	\$290	\$290
NG Service Line	\$130	\$300	\$430
Installed Boiler	\$4,860	\$2,000	<u>\$6,860</u>
Total			\$7,580

- Total number of boilers to replace is 147.
- Average boiler capacity is 360 to 400 MBH.
- Estimated replacement boilers capacities were downsized to reflect current estimated peak and diurnal heat loss conditions at Fort Drum.
- Cost of replacement includes 40 linear feet of natural gas service line feeding from the main distribution line, removal of the old furnace, and installation and hookup of the new furnace.

- Cost of conversion includes replacing the fuel oil barometric damper with a barometric damper compatible with natural gas burners.
- Cost estimate includes 30% for O&P and contingencies.
- Boiler removal costs were obtained from Means (1991).
- Materials costs were obtained from manufacturer's representatives and labor costs from HVAC contractors; verbal estimates were verified with Means (1991).

Results

The complete quantitative results of this ERO appear in Table 2.1. The table contains specific energy, cost, and economic performance data. This ERO affects all buildings on the Old Post with oil-fired boilers covering a total of slightly over 1,115,000 ft² of commercial floorspace.

Budget Implications. The estimated initial cost of the measure is \$1,114,260.

Energy and Cost Savings. It is estimated that this ERO will result in an annual energy savings of 16,412 MBtu at a value of \$125,515.

Operations and Maintenance. Oil-fired furnaces require cleaning and replacing burner tips and orifices and performing operating adjustments to the atomizing pressure, fuel temperature, and burner position; natural gas furnaces do not. The maintenance savings resulting from this ERO is \$8,085.

2.2.11 Boiler Tune-up

Description

There are approximately 150 oil-fired boilers on the Old Post. These boilers should be tuned on an annual basis as part of a regular maintenance program. A boiler tune-up will include mechanical adjustments to controls (linkage, control elements, controller), refractory repair, and cleaning or replacing tips/orifices. Once the mechanical adjustments are complete, the operating conditions can be adjusted to increase efficiency. Adjusting the excess air in the oil-fired boilers on the Old Post will improve their

operating efficiency as well as minimize the soot buildup on heat transfer surfaces caused by incomplete combustion. An efficiency improvement of 2 to 5% is anticipated.

Assumptions

Technical assumptions are as follows:

- The extent of efficiency improvement by tuning a boiler is based in part on the period of time since the previous boiler tune-up. Personnel at Fort Drum have indicated that they are not sure when the last boiler tune-ups were performed on the Old Post and therefore an assumption was made that the last complete tune-up occurred <2 to 10 years ago, indicating that a 2% efficiency improvement is possible.
- The literature indicates, and it is assumed, that an additional 2% efficiency improvement will accrue if boilers are oversized for the load. The majority of boilers on the Old Post are oversized for their load, and therefore a conservative estimate of the total anticipated efficiency improvement from a boiler tune-up is 3.5%.

The cost estimates are as follows:

- Total number of boilers to tuneup is 147.
- The reported cost of a boiler tune-up varies between \$100/boiler and \$500/boilers for boilers in the size range of those at Fort Drum. An average cost of \$250/boiler was established based on conversations with HVAC maintenance contractors and estimates found in the literature.

Results

The complete quantitative results of this ERO appear in Table 2.1. The table contains specific energy, cost, and economic performance data. This ERO affects all buildings with boilers on the Old Post, covering a total of slightly over 115,000,000 ft² of commercial floorspace.

Budget Implications. At an average cost of \$250/tune-up, the initial cost of this measure is estimated to be \$36,750.

Energy and Cost Savings. An average improvement in boiler operating efficiency of 3.5% will result in an annual energy savings of 3416 MBtu at a value of \$16,979.

Energy Security. Properly maintaining combustion equipment saves fuel, which inherently improves energy security.

Operations and Maintenance. Fort Drum operation and maintenance personnel have the training and tools necessary to tune-up the oil-fired boilers. However, due to limited staff this work would be contracted and will not affect current operation and maintenance practices.

Environmental Issues. If a condition exists where boilers are operating on deficient air, incomplete combustion is occurring. In this case, flue gases will contain a higher volume of unburned hydrocarbons and volatile gases. A tune-up will minimize this effect. On the other hand, high excess air (unless extreme) affects stack gas temperature but does not significantly increase or decrease air pollutant levels relative to a boiler running at optimum excess air.

Table 2.1 delineates existing annual operating costs, estimated annual operating costs after the retrofit, and ERO economic performance parameters.

TABLE 2.1. Boiler and Furnace EROs

Existing Furnace and Boiler Operating Parameters

ID	Existing Equipment		Est. Oper. Efficiency (%)	# of units	Size range (kBtu/h)	Present Energy Use (MBtu/yr)	Existing Costs	
	Equipment Type	Approx. Ag (yr)					Energy (\$/yr)	Maintenanc (\$/yr)
1	All FO#2 boilers	7-35	70-75	147	55-2480	97,587	485,121	11,025
2	Newer FO#2 furnaces	< 10	70	383	40-750	102,729	510,685	28,725
3	Older FO#2 furnaces	> 10	66	190	50-750	56,919	282,954	14,250
4	All FO#2 furnaces	7-35	66-70	573	40-750	159,648	793,639	42,975
5	Newer FO#2 boilers	< 10	75	84	55-2480	65,544	325,829	6,300
6	Older FO#2 boilers	> 10	70	63	133-1500	32,043	159,292	4,785
7	All FO#2 boilers	7-35	70-75	147	55-2480	97,587	485,121	11,025

Boiler and Furnace ERO Operating Parameters

ID	ERO Description		Est. Oper. Efficiency (%)	# of units	Size range (kBtu/h)	Post-ERO Energy Use (MBtu/yr)	Post-ERO Costs	
	ERO Description	Approx. Ag (yr)					Energy (\$/yr)	Maintenanc (\$/yr)
1	Tune-up all FO#2 boilers	N/A	73.5-78.5	147	55-2480	94,171	468,142	9,600
2	Convert newer furnace FO#2 burners to NG	New	72	383	40-750	100,675	445,989	7,660
3a	Replace older FO#2 furn. w/new NG eff. furn. (AFUE-82)	New	82	190	40-500	47,874	212,083	3,800
3b	Replace older FO#2 furn. w/new NG cond. furn. (AFUE-93)	New	93	190	40-500	41,551	184,070	3,800
2,3	Convert newer furn./replace older with eff. furn.	New	72/82	573	40-750	148,549	685,072	11,460
2,3	Convert newer furn./replace older with cond. furn.	New	72/93	573	40-750	142,227	630,059	11,460
4a	Replace ALL FO#2 furn. w/new eff. NG furn. (AFUE-82)	New	82	573	40-500	143,412	635,317	11,460
4b	Replace ALL FO#2 furn. w/new cond. NG furn. (AFUE-93)	New	93	573	40-500	125,789	557,244	11,460
5	Convert newer boiler FO#2 burners to NG	New	78	84	55-2480	63,577	281,648	1,680
6	Replace older FO#2 boilers w/new eff. NG boilers (AFUE-81)	New	81	63	133-1500	28,079	124,992	1,260
6	Replace older FO#2 boilers w/new pulse NG boilers (AFUE-9)	New	90	63	133-1500	25,463	112,801	1,260
5,6	Convert newer boilers/replace older with eff. boilers	New	78/81	147	50-2400	91,656	406,640	2,940
5,6	Convert newer boilers/replace older with pulse boilers	New	78/90	147	50-2400	89,040	394,449	2,940
7a	Replace ALL FO#2 boilers w/new eff. NG boilers (AFUE-81)	New	81	147	50-2000	89,690	397,329	2,940
7b	Replace ALL FO#2 boilers w/new pulse NG boilers (AFUE-93)	New	90	147	50-2000	81,175	359,600	2,940

Boiler and Furnace ERO Economic Parameters

ID	ERO Description		Energy Savings (MBtu/yr)	Life (yr)	Energy Savings (\$/yr)	O&M Savings (\$/yr)	Life-Cycle Cost	
	ERO Description	First Cost (\$)					NPV (\$)	Value Index
1	Tune-up all FO#2 boilers	36,750	3,416	n/a	16,978	n/a	24,322	0.66
2	Convert newer furnace FO#2 burners to NG	746,850	2,055	25	64,696	21,065	193,851	0.26
3a	Replace older FO#2 furn. w/new NG eff. furn. (AFUE-82)	466,970	9,045	25	70,871	10,450	662,676	1.42
3b	Replace older FO#2 furn. w/new NG cond. furn. (AFUE-93)	718,570	15,368	25	98,884	10,450	912,747	1.27
2,3	Convert newer furn./replace older with eff. furn.	1,213,820	11,100	25	135,567	31,625	856,527	0.71
2,3	Convert newer furn./replace older with cond. furn.	1,465,420	17,423	25	163,580	31,625	1,105,498	0.76
4a	Replace ALL FO#2 furn. w/new eff. NG furn. (AFUE-82)	1,390,170	16,236	25	158,322	31,515	1,085,261	0.78
4b	Replace ALL FO#2 furn. w/new cond. NG furn. (AFUE-93)	2,196,070	33,859	25	236,394	31,515	1,677,544	0.76
5	Convert newer boiler FO#2 burners to NG	347,275	1,966	25	44,181	4,620	174,432	0.50
6a	Replace older FO#2 boilers w/new eff. NG boilers (AFUE-81)	362,880	3,964	25	34,900	3,465	148,079	0.41
6b	Replace older FO#2 boilers w/new pulse NG boilers (AFUE-9)	477,540	6,580	25	46,491	3,465	240,994	0.50
5,6	Convert newer boilers/replace older with eff. boilers	710,155	5,930	25	79,081	8,085	322,511	0.45
5,6	Convert newer boilers/replace older with pulse boilers	824,815	8,546	25	90,672	8,085	415,426	0.50
7c	Replace ALL FO#2 boilers w/new eff. NG boilers (AFUE-81)	846,720	7,896	25	88,792	8,085	341,949	0.40
7d	Replace ALL FO#2 boilers w/new pulse NG boilers (AFUE-93)	1,114,260	16,412	25	125,515	8,085	749,971	0.67

2.3 BUILDING ENVELOPE EROs

This section covers those EROs that pertain to the building envelope, including ceiling and floor insulation, weatherstripping, caulking, and window quilts.

On the Old-Post, the majority of buildings have had insulation added to the ceiling, walls, and floor under the umbrella of several major renovation projects. However, Fort Drum personnel have indicated that a percentage of these buildings still have sub-optimal ceiling insulation and no existing floor insulation. In addition, door weatherstripping is inadequate on a large percentage of buildings on the Old Post. The effectiveness of adding ceiling and floor insulation, repairing existing weatherstripping and adding new door weatherstripping is evaluated in this section.

The on- and off-post housing units are relatively new, and for the most part are well insulated. However, the insulation installers failed to put insulation on attic access hatches located in ceilings within the heated space of each building. This has resulted in a 2- by 2-ft "hole" in the insulating barrier of each ceiling, allowing large amounts of heat to escape. Installing a fiberglass batt on the back of the attic hatch is included as part of the weatherization package evaluated for all housing units with ceilings. The weatherization package also includes installing switchplate gaskets, caulking door and window seams, and filling plumbing "holes" with insulating material.

2.3.1 Insulate Ceilings

Description

The majority of the original buildings on the Old Post have undergone renovation projects which have included ceiling insulation. However, it was estimated that 17% of these buildings are only insulated to R-11. The addition of a supplementary R-30 blown fiberglass insulation was evaluated.

Assumptions

Technical and cost assumptions are as follows:

- Fort Drum personnel estimate that 17% of the buildings on the Old Post have a sub-optimal insulation level (R-11).

- Estimated energy savings were based on heat-loss calculations performed on the most common building on the Old Post (B-63 type) and projected across all applicable buildings of similar construction on the Old Post.
- Thirteen inches of blown-in fiberglass (R-30) will be added to the existing R-11 at an installed cost of \$0.65/ft².

Results

The complete quantitative results of this ERO appear in Table 2.2 (p. 2.39). The table contains specific energy, cost, and economic performance data. This ERO will affect selected buildings on the Old Post comprising slightly under 550,000 ft² of commercial floor space.

Budget Implications. The estimated initial cost of the measure is \$351,594.

Energy and Cost Savings. It is estimated that this ERO will result in an annual energy savings of 3,415 MBtu at a value of \$16,978.

Energy Security. This measure has very little effect on energy security.

Operations and Maintenance. This measure has no effect on O&M.

Environmental Issues. This measure will result in reduced air pollutants associated with a reduction in fuel combustion.

2.3.2 Insulate Floor Above Crawl Space

Description

The majority of the buildings on the Old Post are of wood frame construction. The common floor framing is 2- x 10-in. joists on 24-in. centers over a vented crawlspace. Through one or more renovation projects, the majority of buildings have been insulated with R-19 fiberglass batts suspended between the floor joists. However, Fort Drum personnel estimate that 7.5% of the buildings still have uninsulated floors. An evaluation was performed to determine the economic effectiveness of adding R-19 to all the uninsulated subfloors that are accessible.

Assumptions

Technical assumptions are as follows:

- 7.5% of the buildings on the Old Post have no floor insulation.
- Estimated savings were based on heat-loss calculations performed on the most common building on the Old Post (B-63 type) and projected across all applicable buildings of similar construction on the Old Post.
- All of the uninsulated subfloors are easily accessible (all subfloors observed during site visit had a clearance of over two feet).
- R-19 floor insulation will be installed at a cost of \$0.50/ft².

Results

The complete quantitative results of this ERO appear in Table 2.2. The table contains specific energy, cost, and economic performance data. This ERO will affect selected buildings with uninsulated, accessible floors on the Old Post, comprising slightly over 205,164 ft² of commercial floor space.

Budget Implications. The estimated initial cost of the measure is \$102,582.

Energy and Cost Savings. It is estimated that this ERO will result in an annual energy savings of 1,607 MBtu at a value of \$7,988.

Energy Security. This measure has very little effect on energy security.

Operations and Maintenance. This measure has no effect on O&M.

Environmental Issues. This measure will result in reduced air pollutants associated with a reduction in fuel combustion.

2.3.3 Exterior Door Weatherstripping

Description

In the winter and summer, many of the exterior wood doors on Old Post buildings are subject to expansion and contraction, causing the existing door jam weatherstripping to fail or become inadequate. In addition, most doors observed were only partially weatherstripped with metal V-strip. Replacing

the existing doors with new, fully weatherstripped metal solid core doors would not be cost effective. Instead, an evaluation was performed to determine the economic effectiveness of refitting the doors with flexible metal weatherstripping to effectively seal their entire perimeter. In addition to the perimeter weatherstripping, rubber threshold gaskets should be replaced when worn to the point where they have become ineffective. By reducing the infiltration of cold air in the winter, weatherstripping will reduce heating requirements and increase occupant comfort.

Assumptions

Technical assumptions are as follows:

- An average of two doors per building require new weatherstripping.
- Estimated savings were based on heat-loss calculations performed on the most common building on the Old Post (B-63 type) and projected across all applicable buildings of similar construction on the Old Post.
- Weatherstripping will be installed by Fort Drum carpenters at a labor cost of \$18.18/h and approximately 3.25 h/door, and a materials cost of \$30/door, for a total cost of \$89/door. Materials cost per Means (1991), labor estimate per S. Rowley/Fort Drum.^(a)

Results

The complete quantitative results of this ERO appear in Table 2.2. The table contains specific energy, cost, and economic performance data. This ERO will affect selected buildings with inadequate weatherstripping on the Old Post, comprising slightly over 1,500,000 ft² of commercial floor space.

Budget Implications. The estimated initial cost of the measure is \$123,532.

Energy and Cost Savings. It is estimated that this ERO will result in an annual energy savings of 6,069 MBtu at a value of \$30,172.

Energy Security. This measure has very little effect on energy security.

(a) Rowley, S. R. 1991. Fort Drum Energy Design Guide, AFZS-EH-OM (11-27), DEH Energy Branch. Fort Drum, New York, July (unpublished document).

Operations and Maintenance. As part of a routine maintenance, Fort Drum craftspeople should replace worn and ineffective weatherstripping when necessary and adjust metal weatherstripping in winter and summer to compensate for expansion and contraction.

Environmental Issues. This measure will result in reduced air pollutants associated with a reduction of fuel combustion.

2.3.4 Window Quilts on the Old Post

Description

Although the great majority of windows in the Old Post have double glazing or thermal storm windows, there is an opportunity for additional energy savings and increased comfort through the installation and use of thermally insulated Window Quilt shades. Window Quilts are designed to provide thermal resistance and reduce infiltration and drafts. Window Quilts are currently being used successfully at a number of locations on the Old Post.

Assumptions

Technical assumptions are as follows:

- Windows in Old Post buildings fall into two categories: large and small.
- 5,836 large Window Quilts and 2,214 small Window Quilts were required to reach a penetration rate of 75% of the windows in the buildings evaluated. Guidance on building type and buildings to include in the analysis was provided by S. Rowley (Fort Drum).
- Window Quilts reduce the thermal conduction of the existing window by an estimated $.33 \text{ Btu/h/ft}^2\text{-}^\circ\text{F}$ as per manufacturer's literature and independent laboratory test results provided by the manufacturer.
- Estimated savings were based on heat-loss calculations performed on the most common building on the Old Post (B-63 type) and projected across all applicable buildings of similar construction on the Old Post.
- Window Quilts are pulled down during working hours in the winter and remain down at night.

Cost assumptions are as follows:

- A large Window Quilt costs \$90; a small one costs \$60.
- Installation is performed in-house. Each unit takes 15 minutes to install at a cost of \$4.10/unit, based on a labor rate of \$16.40/h.
- Material costs were obtained from a supplier local to Fort Drum.
- Installation information and labor rates are per S. Rowley (Fort Drum).

Results

The complete quantitative results of this ERO appear in Table 2.2. The table contains specific energy, cost, and economic performance data. This ERO will affect selected buildings on the Old Post comprising slightly over 1,400,000 ft² of commercial floor space.

Budget Implications. The estimated initial cost of the measure is \$656,097.

Energy and Cost Savings. It is estimated that this ERO will result in an annual energy savings of 8,101 MBtu valued at \$40,270.

Energy Security. This measure has very little effect on energy security.

Operations and Maintenance. This measure has no effect on O&M.

Environmental Issues. This measure will result in reduced air pollutants associated with a reduction in fuel combustion.

2.3.5 Weatherization Package

Description

The weatherization package refers to a group of conservation measures to "seal-up" on- and off-post housing that is already relatively well-insulated but prone to draftiness in the winter. Items included in the weatherization package are insulating attic hatches installing, switchplate gaskets, caulking doors and windows, and filling plumbing holes with insulating material.

Assumptions

Technical assumptions are as follows:

- Housing currently does not have night setback capability.
- Heating design temperature is 70°F.

Cost estimate was provided by Fort Drum and is as follows:

	<u>Labor \$/Unit</u>	<u>Material Cost \$/Unit</u>	<u>Totals (\$)</u>
Outlet Gaskets	27	8	35
Attic Hatch Insulation	14	6	20
Caulk/foam seal drafts	31	<u>10</u>	<u>41</u>
Total			\$96

Results

The complete quantitative results of this ERO appear in Table 2.2. The table contains specific energy, cost, and economic performance data. This ERO will affect all on- and off-post housing heated by fossil fuel comprising slightly under 5,750,000 ft² of residential floor space.

Budget Implications. The estimated initial cost of the measure in off-post housing heated with propane is \$38,592, off-post housing heated with natural gas is \$139,008, on-post housing heated with natural gas is \$208,224, and the initial cost of the measure in on-post housing heated with fuel-oil is \$1,440.

Energy and Cost Savings. It is estimated that this ERO will result in an annual energy savings of 780 MBtu at a value of \$4,691 in off-post propane units; 2,840 MBtu at a value of \$19,256 in off-post natural gas units; 5149 MBtu at a value of \$22,811 in on-post natural gas units; and 65 MBtu at a value of \$323 in on-post oil-fired units.

Energy Security. This measure has very little effect on energy security.

Operations and Maintenance. This measure has no effect on O&M.

Environmental Issues. This measure will result in reduced air pollutants associated with a reduction in fuel combustion.

2.3.6 Window Quilts for Family Housing

Description

Although on- and off-post housing units have dual-pane windows and sliding glass doors, there is an opportunity for additional energy savings and increased comfort through the installation and use of thermally insulated Window Quilt shades. Window Quilts are designed to provide thermal resistance and reduce infiltration and drafts. Window Quilts are currently being used successfully on the Old Post.

Assumptions

Technical and cost assumptions are as follows:

- An average of 10 Window Quilts were required per housing unit to reach a penetration rate of 75%.
- The thermal conductance of existing double-pane windows is $0.5 \text{ Btu/h/ft}^2\text{-}^\circ\text{F}$. Window Quilts reduce the conductance by an estimated $0.33 \text{ MBtu/h/ft}^2\text{-}^\circ\text{F}$.
- Windows account for 15% of the infiltration heat loss in family housing. Window Quilts reduce this component of infiltration by an estimated 15% (per technical product description provided by S. Rowley, Fort Drum).
- Window Quilts are used during winter days and are down and secured throughout the night.
- Average installed cost per Window Quilt is \$75.

Results

The complete quantitative results of this ERO appear in Table 2.2 for fossil-fuel-heated dwelling units and in Table 2.3 for electrically heated family housing units. The tables contain specific energy, cost, and economic performance data. This ERO affects all on- and off-post housing heated by fossil fuel comprising slightly over 5,713,000 ft^2 of residential floor space and all on-post electrically heated housing comprising over 135,000 ft^2 of aggregate floor area.

Budget Implications The estimated initial cost of the measure for on-post natural gas heated units is \$1,626,750 and \$11,250 for on-post units

heated by fuel oil. The first cost of the off-post natural gas units is \$1,086,000, and the off-post propane is \$301,500. The cost of installing Window Quilts in electrically heated on-post housing is \$35,250.

Energy and Cost Savings It is estimated that this ERO will result in an annual energy savings of 24,031 MBtu at a value of \$106,451 in on-post natural gas heated units; 302 MBtu at a value of \$1,501 in on-post fuel oil heated units; 3,639 MBtu at a value of \$21,891 in off-post propane heated units; and 13,254 MBtu at a value of \$89,859 in off-post natural gas heated units. The annual savings in electrically heated on-post housing units are 636,000 kWh at a value of \$35,000 and 489 kW-months at a value of \$2,700.

Energy Security. This measure has very little effect on energy security.

Operations and Maintenance. This measure has no effect on O&M.

Environmental Issues. This measure will result in reduced air pollutants associated with a reduction in fuel combustion.

2.3.7 Insulate Ceilings in All-Electric On-Post Family Housing

Description

All dwelling units in the 8000 Area (Ravenwood family housing area) are heated with electric-resistance baseboard heaters. The structures were originally built with R-19 ceiling insulation. There are five types of structures in the area that differ in size and plan and are identified by rank and number of bedrooms. Ten of the structures are NCO-2 fourplexes that have had ceiling insulation added to an R-40 insulation level. This ERO evaluates adding additional ceiling insulation to the remaining structures: nine NCO-4 fourplexes, two FGO-2 duplexes, three CGO-3 duplexes, and two NCO-4 duplexes. Savings were calculated at R-40, R-50 and R-60.

Assumptions

Technical and cost assumptions are as follows:

- The housing units enumerated above have 102,876 ft² of aggregate floor space divided equally between two floors, resulting in 51,438 ft² of attic space to be insulated.

- Existing and post-retrofit energy consumption were estimated using bin temperature data for Syracuse, New York. These data were available in five-degree bins and 3 daily time periods. The data were subsequently assigned to time periods corresponding to the electric rate schedule. A temperature was calculated for the attic based on these data, and a heat loss through the attic was calculated. The room temperature near the ceiling was assumed to be 75°F.
- An existing insulation level of R-19 was assumed, with the addition of 6, 9, or 12 inches of cellulose, to bring the total attic R values to 40, 50, or 60, respectively.
- The cost of blowing in the additional insulation is a function of insulation value (R) added: $\text{cost} = \$0.03 + 0.0263 * R$, based on data reported in Means (1991). The resulting costs for the three levels of insulation evaluated for this ERO are as follows:

6-in. cellulose	\$0.555/ft ²
9-in. cellulose	\$0.82/ft ²
12-in. cellulose	\$1.08/ft ²

Results

The complete results of this ERO appear in Table 2.3. The table contains specific energy, cost and economic performance data.

Budget Implications. The most cost effective of the three insulation levels evaluated is R-60. It is estimated that initial cost of this ERO will be \$55,656.

Energy and Cost Savings. It is estimated that this ERO will result in an annual energy savings in electrically heated on-post housing units of 98,120 kWh at a value of \$5,079 and 125 kW-months at a value of \$689.

Energy Security. This measure has no significant effect on energy security.

Operations and Maintenance. This measure has no significant effect on O&M.

Environmental Issues. Implementation of this ERO will decrease the need for electricity that may be produced from sources that have negative environmental impacts.

TABLE 2.2. Building Envelope Fossil Fuel EROs

Building Envelope ERO Economic Parameters

ID	ERO Type	Sector	Fuel Type	First Cost (\$)	Life (yr)	Energy Savings (MBtu/yr)	Energy and O&M Savings		Life Cycle Cost	
							Energy (\$/yr)	O&M (\$/yr)	NPV (\$)	Value Index
1	Ceiling Insulation	Old Post	FO2	351,594	N/A	3,415	16,978	N/A	(65,113)	-0.19
1a	Floor Insulation	Old Post	FO2	102,582	25	1,607	7,988	N/A	32,206	0.31
1b	Weatherstripping	Old Post	FO2	123,532	25	8,069	30,172	N/A	385,576	3.12
1c	Window Quilts	Old Post	FO2	656,097	25	8,101	40,270	N/A	23,395	0.04
2a	Window Quilts	Off-Post FH	Propane	301,500	25	3,639	21,891	N/A	34,100	0.11
2b	Window Quilts	Off-Post FH	NG	1,086,000	25	13,254	89,859	N/A	523,265	0.48
2c	Window Quilts	On-post FH	NG	1,626,750	25	24,031	106,451	N/A	279,653	0.17
2d	Window Quilts	On-post FH	FO2	11,250	25	302	1,501	N/A	14,078	1.25
3a	Weatherization Package	Off-post FH	NG	139,008	25	2,840	19,256	N/A	205,835	1.48
3b	Weatherization Package	Off-post FH	Propane	38,592	25	780	4,691	N/A	33,322	0.86
3c	Weatherization Package	On-post FH	NG	208,224	25	5,149	22,811	N/A	200,291	0.96
3d	Weatherization Package	On-post FH	FO2	1,440	25	65	323	N/A	4,012	2.79

TABLE 2.3. All-Electric on Post Family Housing Envelope EROs

Existing family housing envelope operating parameters

ID	Existing Equipment			Energy Consumption (kWh)			Sum of 12 Monthly Coincident Demands (kW-mo)		
	ERO Type	R Value	Fuel Type	On-Peak	Mid-Peak	Off-Peak	On-Peak	Mid-Peak	Off-Peak
1	Insulation	19	Electric	79,129	NA	67,992	187	NA	NA
2	Windows	NA	Electric	190,728	NA	445,032	764	NA	NA

Family housing envelope ERO parameters

ID	Energy Resource Opportunity			Energy Consumption (kWh)			Sum of 12 Monthly Coincident Demands (kW-mo)		
	ERO Description	R Value		On-Peak	Mid-Peak	Off-Peak	On-Peak	Mid-Peak	Off-Peak
1a	Add Insulation over Ceiling	40		39,565	NA	33,996	93	NA	NA
1b	Add Insulation over Ceiling	50		31,652	NA	27,197	75	NA	NA
1c	Add Insulation over Ceiling	60		26,347	NA	22,654	62	NA	NA
2	Install Window Quilts	NA		153,676	NA	358,578	275	NA	NA

Family housing envelope ERO economics

ID	Non-Energy Costs				First Year Energy & Demand Savings					Life Cycle Cost			
	First Cost \$	Exist. O&M \$	Retrofit O&M \$	Life, yr.	Energy (kWh)	Demand (kW-mo)	Energy (1992 \$)	Demand (1992 \$)	Total (1992 \$)	No Utility Rebate		50% Utility Rebate	
										NPV \$	Value Index	NPV \$	Value Index
1a	28,600	0	0	NA	73,560	94	3,808	518	4,326	32,293	1.13	46,593	3.26
1b	42,128	0	0	NA	88,272	112	4,569	617	5,186	30,881	0.73	51,945	2.47
1c	55,656	0	0	NA	96,120	125	5,079	689	5,768	25,539	0.46	53,367	1.92
2	35,250	0	0	NA	123,506	489	5,959	2,694	8,654	86,567	2.46	104,192	1.48

2.4 HIGH-TEMPERATURE HOT WATER (HTHW) SYSTEM EROs

High-temperature hot water is provided to buildings on the New Post through a district heating loop. The HTHW is produced onsite by the Jones coal-fired heating plant. Fort Drum pays both a usage fee based on the difference between the MBtus measured leaving from and returning to the Jones plant, and a monthly capacity charge. In an effort to reduce the usage fee, Fort Drum requested that PNL evaluate the potential savings associated with a reduced HTHW supply temperature. In addition, evaluations were performed on decommissioning an unused section of HTHW line, adding package boilers to two buildings located on a remote loop and decommissioning that loop section, and repairing and replacing a section of HTHW line characterized by unusually high heat loss.

2.4.1 Adjust (Lower) HTHW Temperature and Pressure

Description

The HTHW system is operated under the seasonal schedule of supply temperature setpoints shown below. Fort Drum requested that PNL evaluate lowering these seasonal supply temperatures to reduce thermal losses (i.e., line losses) associated with the buried HTHW system piping. Fort Drum provided PNL with a revised supply temperature schedule, shown in the right-hand column, for the evaluation. Verification is needed to determine if peak monthly loads can be satisfied with the revised setpoint schedule.

Supply Temperature Schedule with Revised Temperatures

	<u>Current</u> <u>(°F)</u>	<u>Revised</u> <u>(°F)</u>
1 December - 1 March	360	350
1 March - 1 April	350	250
1 April - 1 May	340	225
1 May - 1 June	320	200
1 June - 1 October	300	200
1 October - 1 November	320	225
1 November - 30 November	340	250

To estimate both the current and proposed line-loss values, a model was developed by PNL based on ASHRAE standards. Inputs to the model include HTHW

supply and return temperatures, pipe and conduit diameter, insulation thickness and conductivity, earth temperature and conductivity, and conduit depth underground.

The model was run for the 10 different pipe diameters using seasonal average supply and return temperatures. The outputs of the model, given in MBtu/yr-ft, were multiplied by an estimated line-length for each given pipe size to arrive at a total line-loss in MBtu/yr.

Assumptions

Technical assumptions are as follows:

- The buried line is approximately 25 miles long and ranges from 2 to 16 inches in diameter.
- Current and proposed seasonal HTHW temperatures are as reported by Fort Drum personnel.
- The current conditions of temperature and mass flow are assumed to be such that the proposed temperature drop will not restrict the capability of individual building heat exchangers to meet existing loads.
- The fuel charge for the HTHW is approximately \$4.29/MBtu.
- The HTHW system operates 24 hours per day, 365 days per year.

Results

The complete quantitative results of this ERO appear in Table 2.4, which contains specific energy cost, and economic performance data (see p. 2.50).

Budget Implications. Lowering the HTHW setpoint has no appreciable material or installation costs.

Energy and Cost Savings. The line-loss model was run using the existing temperature schedules where a line-loss value of approximately 155,000 MBtu/yr was calculated. After adding a heat loss value representing losses through damaged sections of pipe (16,000 MBtu/yr),^(a) this value becomes consistent with the values previously calculated by both PNL and Fort Drum personnel. A

(a) Ricwil. 1991. Central HTHW Distribution Heat Loss Survey for Fort Drum (unpublished document).

second run of the model was completed using the proposed HTHW supply temperature. The calculated line-loss under existing conditions is 155,000 MBtu/yr.

After reducing the HTHW supply temperature, the calculated line loss is 116,000 MBtu/yr, for a savings of 39,000 MBtu/yr. At a fuel charge of \$4.29/MBtu, a cost savings of approximately \$167,500/yr is estimated for this ERO.

Energy Supply and Demand Issues. Energy supply and demand issues are not applicable.

Reliability and Energy Security. Reliability and energy security issues are not applicable.

Operations and Maintenance. A small reduction in operations and maintenance cost should be realized with a lower operating temperature. At a lower temperature, and resulting lower pressure, maintenance items such as expansion joints and valves have longer lives and require less maintenance. Because of the difficulty in quantifying this potential reduction, a reduced value was not considered in this calculation.

Environmental Issues. If the Jones plant cut back on electricity generation as a result of the decreased demand for thermal energy, the ERO would be responsible for reduced coal burning and associated air, water, and land emissions.

2.4.2 Decommission Loop Section/Add Package Boilers

Description

The section of the HTHW system, between manholes 77 and 83, is considered for decommissioning because of the limited building energy use and relatively high line-loss. Near the end of this section are two buildings (Buildings 10790 and 10785). In order to decommission this section of line, packaged natural gas-fired boilers were sized to replace the heat received from the HTHW system.

The line-loss model described in Section 2.4.1 was run to estimate the line-loss values specific to this Section. The output of the model was

multiplied by the estimated line length to arrive at the line-loss for this Section. This line-loss was added to the estimated building consumption for a total HTHW use for this section.

When decommissioning sections of HTHW systems, particularly sections that have plans for future use, it is recommended that a system of corrosion prevention be considered. The most typical corrosion prevention, or "lay-up," procedure used with HTHW systems is nitrogen purging. This procedure involves draining and drying the section of line and the insulation. Once dried, the line is filled with pressurized nitrogen and capped. Lines that do not leak can remain in this lay-up state, free from corrosion, indefinitely.

Assumptions

Technical assumptions are as follows:

- The buried line between manholes 77 and 83 is approximately 4,000 ft long and has 3-in. supply and return pipe diameters.
- The fuel charge for the HTHW system is approximately \$4.29/MBtu.
- This portion of line is assumed to operate 24 hours per day, 365 days per year, following the temperature schedule provided by Fort Drum personnel.
- For an initial approximation, packaged natural gas boilers were sized based on existing heat-exchanger sizes (ratings). Building 10790 has a boiler sized at almost 800 MBH, while building 10785 has a boiler of approximately 2,200 MBH.
- Proposed packaged boilers were assumed to be 83% efficient. Current heat exchangers were assumed to be 95% efficient. The difference, 12%, was factored into estimated energy use by the natural gas boilers.

The cost estimate is as follows:

Costs:	<u>Materials</u>	<u>Labor</u>	<u>Total</u>
Line lay-up	\$1,290	\$2,580	\$3,900
Boilers	<u>\$20,800</u>	<u>\$4,500</u>	<u>\$25,300</u>
Totals	\$22,090	\$7,080	\$29,170

- Cost of lay-up was estimated with guidance from a HTHW system manufacturer and an installation contractor.

Results

The complete quantitative results of this ERO appear in Table 2.4. The table contains specific energy, cost, and economic performance data. This ERO affects two buildings on the New Post comprising a total of 20,800 ft² of commercial floor space.

Budget Implications. The estimated initial cost of the measure is \$29,170.

Energy and Cost Savings. The estimated energy savings are the line-loss minus the incremental energy use of the package boilers over the heat exchangers. The line-loss is estimated to be 3,600 MBtu/yr, while the increased energy use of the boilers is 800 MBtu/yr. Therefore, this ERO has a net estimated energy savings of 2,761 MBtu/yr.

The annual dollar savings associated with this fuel-switching measure is \$10,916.

Energy Supply and Demand Issues. This measure will slightly increase Fort Drum's reliance on natural gas and slightly reduce its demand for HTHW generated by burning coal. Overall, this ERO has no significant affect on energy supply and demand issues.

Energy Security. If the lay-up procedure is followed, this ERO has a positive effect on energy security in that, in the case of natural gas service disruption, the laid-up line could be recommissioned to provide HTHW to the buildings.

Operations and Maintenance. The incremental annual maintenance resulting from this ERO is \$600. Assuming the line remains leak-free, there is no annual maintenance associated with lay-up.

Environmental Issues. This conservation measure may lead to a light reduction in air emissions as the primary fuel switches from coal to natural gas and the total energy requirement is reduced.

2.4.3 Decommission Loop Section

Description

The two sections of HTHW system between manholes 10 and 17 and manholes 47 and 49 were considered for decommissioning because currently there are no buildings on these section using the HTHW line. The line-loss model was used to estimate the loss specific to these sections.

Assumptions

Technical assumptions are as follows:

- The buried line between manholes 10 and 17 is approximately 5400 ft long and has both 4- and 5-in. supply and return piping.
- The buried line between manholes 47 and 49 is approximately 1400 ft long and has both 3- and 4-in. supply and return piping.
- The fuel charge for the HTHW system is \$4.29/MBtu.
- The lines are assumed to operate 24 h/day, 365 days/yr.
- Because there are no buildings on the section between manholes 10 and 17, the HTHW is passed through an expansion valve, reducing the temperature to 180°F.
- The section between manholes 47 and 47 is assumed to operate at normal line temperatures.
- The lay-up procedure, described previously, is also recommended for this ERO.
- Cost of lay-up was estimated with guidance from a HTHW system manufacturer and an installation contractor. For these sections of line an estimated one time lay-up cost of \$6,130 was used.

Results

The complete quantitative results of this ERO appear in Table 2.4. The table contains specific energy, cost, and economic performance data.

Budget Implications. Assuming the line is leak-free, a one-time lay-up cost of \$6,130 was estimated.

Energy and Cost Savings. It is estimated that this ERO will result in an annual energy savings of 3,750 MBtu at a value of \$16,106.

Energy Supply and Demand Issues. Not applicable.

Energy Security. If the lay-up procedure is followed, this ERO has a positive effect on energy security. If necessary, the laid-up line could be recommissioned to provide HTHW to any buildings constructed in the future.

Operations and Maintenance. Assuming the line is leak-free, there is no annual maintenance associated with lay-up.

Environmental Issues. By decommissioning this unused section of thermal loop the HTHW demand is reduced. If the Jones plant reduces generation because of this reduction of demand, then the associated environmental benefits of reduced coal combustion will accrue.

2.4.4 Repair or Replace Pipe Insulation

Description

An infrared heat loss survey was conducted by Ricwil Piping Systems Services over the approximately 25 miles of the HTHW system. The Ricwil study^(a) identified 13 sections of pipe (approximately 2326 feet) as losing excessive energy. Ricwil classified two of the 13 sections as priority-1, requiring immediate repair. Another two sections, Ricwil classified as priority-2 and recommended testing. The remaining nine sections were analyzed in the study, but no immediate corrective action was recommended.

From the four sections of pipe classified as priority-1 and priority-2, Ricwil estimated a heat loss value of approximately 10,000 MBtu/yr. This value of heat loss indicates a possible wet condition inside the insulated conduit. Ricwil recommends a variety of tests to determine the source of the moisture. Corrective actions, and therefore cost, will be determined based on results of further investigation.

Assumptions

Technical assumptions are as follows:

(a) Ricwil. 1991. Central HTHW Distribution Heat Loss Survey for Fort Drum (unpublished document).

- From the Ricwil study, it is assumed that each section of line considered for corrective action has two leaks.
- Excessive heat loss most likely results from leaks in the external protective conduit and not the internal piping. This assumption was verified with the piping system designer and installation contractor.
- The fuel charge for the HTHW is approximately \$4.29/MBtu.
- The HTHW system is assumed to operate 24 h/day, 365 days/yr.

The cost estimate is as follows:

Costs:	<u>Materials</u>	<u>Labor</u>	<u>Total</u>
Tracer Gas	6,000	10,000	16,000
Repair Conduit	<u>8,000</u>	<u>40,000</u>	<u>48,000</u>
Totals	\$14,000	\$50,000	\$64,000

Results

The complete quantitative results of this ERO appear in Table 2.4. The table contains specific energy, cost, and economic performance data. The recommended corrective measures and estimated energy savings values reported by Ricwil were used in this analysis. While the estimated costs of repair are conservative, the actual cost may vary based on the outcome of investigation during repair.

Budget Implications. The total estimated cost of this measure is \$64,000.

Energy and Cost Savings. The estimated energy savings results from the reduced losses in the four identified sections of line. Ricwil calculated these savings to be 10,000 MBtu/yr. Assuming a HTHW fuel charge of \$4.29/MBtu, a net fuel cost savings of \$43,000/yr is estimated for this ERO. The NPV of this measure is \$660,135.

Energy Supply and Demand Issues. Energy supply and demand issues are not applicable to this measure.

Reliability and Energy Security. This ERO has a positive effect on energy reliability. Following the recommended corrective actions will increase the reliability of the HTHW system and make the system less susceptible to catastrophic failure.

Environmental. If the Jones plant reduces generation because of the reduction of HTHW demand created by this measure, then the associated environmental benefits of reduced coal combustion will accrue.

TABLE 2.4. New Post HTHW System ERO

New Post HTHW System ERO Economic Parameters

ID	ERO Type	Sector	Fuel Type	First Cost (\$)	Life (yr)	Energy Savings (MBtu/yr)	Energy and O&M Savings		Life Cycle Cost	
							Energy \$	O&M \$	NPV (\$)	Value Index
1a	Lower HTHW Temperature	New Post	HTHW	Unknown	N/A	38,000	187,500	N/A	2,824,128	N/A
1b	Decommission Loop/Add Pkg. Boilers	New Post	HTHW	29,170	25	2,781	10,918	800	113,848	3.90
1c	Decommission Unused Loop Section	New Post	HTHW	8,130	N/A	3,750	16,108	N/A	265,421	43.30
1d	Replace or Repair Pipe Insulation	New Post	HTHW	64,000	25	10,000	42,950	N/A	660,135	10.31

2.5 DOMESTIC WATER HEATING EROs

Fort Drum uses a variety of methods to provide domestic hot water. On the Old Post, buildings with high hot water use (such as barracks) typically have a 100-gallon oil-fired water heater. Converting the Old Post to natural gas would require these water heaters to be replaced with natural gas units.

Administration buildings, and similar classes of buildings characterized by modest hot water requirements, usually have small (15- to 50-gallon) electric water heaters. These small electric water heaters are well suited to provide hot water for intermittent and minor loads and should not be replaced.

There are also a small number of propane-fired water heaters on the Old Post. It is anticipated that a conversion to natural gas on the Old Post would include the elimination of the propane-fired equipment; therefore, the replacement of the propane-fired water heaters with natural gas units was evaluated in conjunction with the replacement of the oil-fired water heaters.

On- and off-post housing has conventional residential water heaters of 30-, 40-, or 50-gallon capacities, fired by natural gas or propane (with the exception of the on-post LeRay complex, which has oil-fired units, and the Ravenwood complex, which is all-electric). An analysis was also performed to convert the LeRay Complex water heaters to natural gas.

On the New Post, hot water is provided by heat exchangers (HTHW) and by a limited number of individual natural gas-fired units.

Two EROs were evaluated in this section: replacement of oil-fired and propane-fired water heaters on the Old Post with high-efficiency natural gas-fired units, and retrofit of thermally activated vent dampers on all family housing natural gas and propane-fired water heaters.

2.5.1 Replace Oil- and Propane-Fired Commercial Water Heaters on the Old Post with Efficient Natural Gas Units

Description

This measure is necessary to convert from fuel oil and propane to natural gas on the Old Post. The New York State Energy Conservation Construction Code calls for commercial gas-fired water heaters to have a minimum thermal

efficiency of 75%. In addition, the code has strict standards for standby loss. To meet the standby loss requirements, a water heater should have an electric flue damper upstream of the draft diverter and an intermittent ignition device. The water heater used as the basis for this analysis has a thermal efficiency of 80%.

In a barracks building on the Old Post, a 120-gallon water storage tank was used in conjunction with a 100-gallon water heater. The storage tank was plumbed in series with the water heater, and a 1/12-horsepower pump provided continuous circulation between the two tanks. The use of high-recovery, energy-efficient water heaters will eliminate the need for the extra storage tank and circulation pump.

Assumptions

Technical assumptions are as follows:

- Existing fuel oil- and propane-fired water heaters in commercial buildings have a capacity of 100 gallons and a thermal efficiency of 68%.
- New commercial 100-gallon natural gas-fired water heaters have a thermal efficiency of 80%.
- The total maintenance savings per water heater is \$55 per Fort Drum report. Oil-fired equipment receives annual servicing, which consumes an average of 3 hours per appliance; a natural gas appliance of similar average size would require approximately 1 hour annually. Maintenance labor costs \$20/h. Materials savings per appliance: one nozzle at \$5 and one oil strainer at \$10.

Cost estimates for a high-efficiency 100-gallon commercial water heater are as follows:

	<u>Material</u>	<u>Labor</u>	<u>Total</u>
Water Heater Removal	--	\$130	\$130
Installed Water Heater	\$1,687	\$260	<u>\$1,947</u>
Total			\$2,077

- Cost includes removal of the old water heater and hookup and installation of the new water heater.
- Cost estimate includes 30% for O&P and contingencies.

- Water heater removal costs were obtained from Means (1991).
- Materials costs were obtained from manufacturer's representatives and labor costs from plumbing contractors, and these estimates were verified with Means (1991).

Results

The complete quantitative results of this ERO appear in Table 2.5. The table contains specific energy, cost, and economic performance data. This ERO affects all buildings on the Old Post with commercial oil- and propane-fired water heaters covering a total of slightly under 1,800,000 ft² of commercial floorspace.

Budget Implications. The estimated initial cost of the replacing the Old Post commercial oil-fired units is \$606,484, and the Old Post commercial propane-fired units is \$68,541.

Energy and Cost Savings. It is estimated that this ERO will result in an annual energy savings of 6,306 MBtu at a value of \$58,073 for the oil-fired commercial water heaters on the Old Post, and 286 MBtu at a value of \$1,721 for on-post propane replacement.

Energy Security. Most buildings on the Old Post have a dedicated underground tank. Currently fuel oil tanks are refilled approximately once a month. Although the price of fuel oil has fluctuated significantly, supply has not been disrupted to date. Natural gas would probably be delivered to the Old Post by one large distribution main. A break in this line or a supply disruption would result in a complete and immediate loss of space and water heating capability in all buildings unless a back-up system is installed.

Operations and Maintenance. Oil-fired water heaters require cleaning and replacing burner tips and orifices and performing operating adjustments that natural gas water heaters do not need. The maintenance savings resulting from this ERO is \$16,060.

Environmental Issues. Environmental benefits that will accrue as a result of the conversion to natural gas include the elimination of oil leaks and spills (upon removal of the storage tanks and piping) and a slight reduction in carbon monoxide and hydrocarbon particulate matter emissions into the

air. Quantifying the economic benefits of these environmental improvements, however, is beyond the scope of this study.

2.5.2 Replace Oil-Fired Residential Water Heaters on the Old Post with Efficient Natural Gas Units

Description

This measure is necessary to convert from fuel oil to natural gas on the Old Post. The New York State Energy Conservation Construction Code calls for residential gas-fired water heaters to have a minimum energy factor of greater than or equal to 0.60 to 0.0019V, where V is equal to the volume of the tank. The new natural gas units recommended in this analysis have an energy factor of 0.64 and a recovery efficiency of 76%.

Assumptions

Technical assumptions are as follows:

- Existing oil-fired water heaters in the LeRay family housing complex hold 50 gallons and have an energy factor of 0.53 and a recovery efficiency of 70%.
- New residential natural gas-fired water heaters have an energy factor of 0.64 and a recovery efficiency of 76%.
- The total maintenance savings per water heater is \$55 per Fort Drum report. Oil-fired equipment receives annual servicing, which consumes an average of 3 hours per appliance; a natural gas appliance of similar average size would require approximately 1 hour annually. Maintenance labor costs \$20/h. Materials savings per appliance: one nozzle at \$5 and one oil strainer at \$10.

Cost estimates for a high-efficiency 50 gallon residential water heater are as follows:

	<u>Material</u>	<u>Labor</u>	<u>Total</u>
Water Heater Removal	--	\$130	\$130
Installed Water Heater	\$371	\$180	<u>\$551</u>
Total			\$681

- Cost includes removal of the old water heater and hookup and installation of the new water heater.
- Cost Estimate includes 30% for O&P and contingencies.

- Water heater removal costs were obtained from Means (1991).
- Materials costs were obtained from manufacturer's representatives and labor costs from plumbing contractors, and these estimates were verified with Means (1991).

Results

The complete quantitative results of this ERO appear in Table 2.5. The table contains specific energy, cost, and economic performance data. This ERO affects all family housing units on the Old Post with residential oil-fired water heaters covering a total of 36,556 ft² of residential floorspace.

Budget Implications. The estimated initial cost of the replacing the Old Post residential oil-fired units is \$10,215.

Energy and Cost Savings. It is estimated that this ERO will result in an annual energy savings of 26 MBtu at a value of \$432.

Energy Security. Most buildings on the Old Post have a dedicated underground tank. Currently, fuel-oil tanks are refilled approximately once a month. Although the price of fuel oil has fluctuated significantly, supply has not been disrupted to date. However, tanks running dry (prompting "no heat calls") have been a problem.

Natural gas would probably be delivered to the Old Post by one large distribution main. A break in this line or a supply disruption would result in a complete and immediate loss of space and water heating capability in all buildings unless a back-up system is installed.

Operations and Maintenance. Oil-fired water heaters require cleaning and replacing burner tips and orifices and performing operating adjustments that natural gas furnaces do not need. The maintenance savings resulting from this ERO is \$825.

Environmental Issues. Environmental benefits that will accrue as a result of the conversion to natural gas include the elimination of oil leaks and spills (upon removal of the storage tanks and piping) and a slight reduction in carbon monoxide and hydrocarbon particulate matter emissions into the air. Quantifying the economic benefits of these environmental improvements, however, is beyond the scope of this study.

2.5.3 Thermally Activated Vent Dampers

Description

Fort Drum requested that PNL evaluate the Thermally Activated Vent Dampers (ERO) for application on natural gas and propane-fired water heaters in on- and off-post housing. Thermally activated vent dampers are installed downstream of the draft diverter to reduce airflow through the tank heat exchanger when the water heater is in the standby mode. Thermal vent dampers do not close tight and, as a result, may not have a significant effect on changing the performance efficiency of the small (40- and 50-gallon with 34,000-40,000 MBtu/h inputs) residential water heaters in question. To date little performance data on thermally activated vent dampers have been collected. The data that are available typically pertain to an electro-mechanical flue damper installed upstream of the draft diverter in large commercial water heaters.

A thermally activated vent damper may cause heated air flow to spill through the draft diverter into the surrounding area. Because the water heaters are located in closets within the heated space of the housing units on Fort Drum, some of the heat that would have gone up the flue should instead transfer into the living space.

The small volume of empirical data that exists indicates that an increase in water heater efficiency of 4.5% is possible from this measure, and this figure was used as the basis for the economic evaluation.

Assumptions

Technical assumptions are as follows:

- A thermal vent damper can easily be installed in the vent of all fossil fuel-fired water heaters in family housing units.
- The vent damper will result in an increase in water heater thermal efficiency of 4.5%.
- Water heater capacity is 30 to 50 gallons with standard flue size.
- Vent dampers are purchased directly by Fort Drum and installed by Fort Drum sheet metal workers at \$36/h. Vent damper installation takes 1/2 hour (per S. Rowley).

Cost estimates are as follows:

	<u>Material</u>	<u>Labor</u>	<u>Total</u>
Installed Vent Damper	\$50	\$18	\$68

Results

Budget Implications. The complete quantitative results of this ERO appear in Table 2.5. The table contains specific energy, cost, and economic performance data. There are 402 units of off-post housing that burn propane and 1,448 that use natural gas. The total cost to add vent dampers to the units burning propane is \$27,336, while the total cost for the vent dampers on the natural gas units is \$98,464. There are 2,169 on-post housing units with natural gas water heaters; the total cost of adding a thermally activated vent damper to each unit is \$147,492.

Energy and Cost Savings. Estimated savings for off-post propane is 416 MBtu at a value of \$2,501; off-post natural gas is 1,530 MBtu at a value of \$10,373; and on-post natural gas is 2,168 MBtu at a value of \$9,605.

Operations and Maintenance. This measure has little impact operation and maintenance activities.

Energy Security Issues. The energy security impacts of this measure are minimal.

Environmental Issues. This measure will result in reduced air pollutants associated with a reduction fuel combustion.

TABLE 2.5. Domestic Water Heating EROs

Domestic Water Heating ERO Economic Parameters

ID	ERO Type	Sector	Fuel Type	First Cost (\$)	Life (yr)	Energy Savings (MBtu/yr)	Energy and O&M Saving		Life Cycle Cost	
							Energy (\$)	O&M (\$)	NPV (\$)	Value Index
1A	Replace w/efficient NG Unit	Old Post	FO2	606,484	25	6,683	59,743	16,060	395,392	0.68
1B	Replace w/efficient NG Unit	Old Post	Propane	68,541	25	286	1,721	N/A	(15,134)	-0.22
1C	Replace w/efficient NG Unit	On-post FH	FO2	10,215	25	26	432	825	6,614	0.65
2A	Vent Damper	On-post FH	NG	147,492	25	2,168	9,605	N/A	24,514	0.17
2B	Vent Damper	Off-post FH	NG	98,464	25	1,530	10,373	N/A	87,303	0.89
2C	Vent Damper	Off-post FH	Propane	27,336	25	416	2,502	N/A	11,018	0.40

2.6 HVAC SYSTEM EROs

The HVAC systems in the buildings on the Old Post are typically forced-draft, constant-volume furnace/ventilation units or boilers with baseboard convectors and/or fan coil units. These systems are typically controlled by direct-acting thermostats; however, not all distinct zones have separate thermostatic control. A frequency modulated (FM) system provides relatively effective night and weekend setback for a large number of the buildings on the Old Post. The FM system is programmed with prescheduled setback times. It sends an FM radio signal to a receiver in each building. The signal activates thermostats (with preset temperatures) located within the heated space building. The thermostats are secured from tampering or temperature reset by clear plastic lock-boxes.

The first HVAC system ERO evaluates the economic and energy efficiency impacts of increasing the penetration rate of the FM system to cover all the remaining buildings which currently do not have night and weekend setback capability.

Programmable setback thermostats exist in a number of Old Post buildings. Those observed during the site visit had lost their program and appeared to be bypassed. Fort Drum has indicated that these thermostats are not reliable and require too much maintenance and program updating and will therefore be replaced by the FM system.

In New Post buildings, heat exchangers provide HTHW to heating coils in air-handling units (AHU) and to perimeter radiant convectors. The perimeter convectors supply the majority of heat, while the AHU heating coils temper the supply air, which is typically 100% outside air. Return air is not common in New Post buildings. Overall HVAC system control is provided by 7-day, 24-hour, manually set, electro-mechanical time clocks. Ventilation control is provided by the clocks and thermostatic control. This system should provide adequate, but not optimal, control of HVAC equipment. However, schedule program pins (which provide on-off control) in all of the time clocks have reportedly been pulled allowing the systems to run continuously. Problems that prevent these timeclocks from being utilized effectively include 1) large

variations in the time required to recover from night setback,^(a) 2) day-light savings time reset requirements, and 3) chronic complaints from building occupants.

The second ERO evaluated in this section addresses the issue of Effect Night Setback.

The third ERO in this section evaluates the effectiveness of integrating a CO₂-based controller with the existing ventilation control in New Post buildings to provide accurate fresh-air volumes and eliminate unnecessary outside air.

On- and off-post family housing have direct acting thermostats which control furnaces or boiler/hydronic heating systems. Setback thermostats were evaluated as a replacement to existing thermostats.

2.6.1 Add Buildings to Existing FM Control System

Description

The Old Post currently uses a radio control system to operate the heating thermostats in many of its buildings. This system provides a specific control schedule for buildings in each load group category. Each load group has a predefined setup/setback, 365-day time schedule, and is controlled by a particular radio frequency. Hardware consists of a central computer, 1 FM transmitter and antenna, an FM receiver in each building, a day thermostat (set at 68°F), and a night thermostat (set at 55°F) with a 1-hour override timer. Fort Drum has purchased the hardware for the remaining buildings on the Old Post that do not currently have thermostat night and weekend setback capability. All that remains is for the hardware to be installed.

Domestic water heaters may also be controlled on the same night setback schedules as the heating systems. The cost-effectiveness of this application

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- (a) This is due to the perimeter radiation systems' being designed with little excess capacity. Low excess capacity is generally a desirable design characteristic. However, the low excess capacity means that night setback can only be effectively implemented in conjunction with a reliable control scheme that computes the correct time to begin recovery based on daytime setpoint and the indoor and outdoor temperature (and, in some cases, internal gains) at the start of recovery.

of the FM system should be evaluated on a case-by-case basis because of variations in water heater size, fuel type, and hot water load among Old Post buildings. This ERO was screened and determined to have too small an impact to justify a complete analysis. However, because the costly elements of the FM system have already been purchased, the measure should be seriously considered for implementation in buildings already controlled by the FM system, as well as those to be added in the future.

Assumptions

Technical and cost assumptions are as follows:

- Setback period is equivalent to 12 h/day five days/week in administration buildings and 8 h/day, seven days/week in barracks buildings.
- Estimated savings were based on heat-loss calculations performed on the most common building on the Old Post (B-63 type) and projected across all applicable buildings of similar construction on the Old Post.
- Fort Drum has the hardware in stock for 100 buildings.
- Installation will be performed by in-house electricians at a cost of \$288/unit. Two men, 4 hours at \$36/h, per S. Rowley/Fort Drum. Miscellaneous materials, wiring, conduit, and spare parts, estimated at \$20/building.

Results

The complete quantitative results of this ERO appear in Table 2.6 (see p. 2.68). The table contains specific energy, cost, and economic performance data. This ERO will affect selected buildings on the Old Post comprising slightly over 340,000 ft² of commercial floor space.

Budget Implications. The initial cost of this ERO is \$30,500.

Energy and Cost Savings. It is estimated that this ERO will result in an annual energy savings of 2,883 MBtu at a value of \$14,331.

Energy Security Issues. Improved energy efficiency leads to reduced energy consumption which inherently strengthens energy security.

Environmental Issues. This measure will result in reduced air pollutants associated with a reduction fuel combustion.

2.6.2 Effect Night Setback

Description

This energy resource opportunity was originally recommended in a TVA energy study for implementation in administration buildings. The original estimates of energy savings were evaluated and adjusted to reflect current understanding of energy enduse in the administration buildings. Original cost estimates were also checked for accuracy and confirmed.

Each battalion headquarters building has its outside air fans and hot water pumps operated by an electro-mechanical time clock. Each of these buildings has a duty office that requires heat 24 hours a day. Because of this, the total building is maintained at 68°F, and the existing night setback does not function. To be effective, the time clocks have to be reset after electrical interruptions and at daylight savings time changes.

Savings could be realized by adding an electric heater in the duty office and setting back the building hot water pumps, outside air fans, and existing manual-controlled summer ventilation system fans. However, the existing heating system is inadequate to recover from night setback at extremely low outside air temperatures, so this measure does not apply under those conditions.

It is recommended that this ERO be implemented by taking the following actions: 1) add a 1.5-kW electric heater and building heat override switch in the duty office. This will allow the building to operate at night setback; 2) remove the functions from the mechanical time clocks and install them on the existing astronomical time clock because of its added features; 3) add dampers, return air ducting, and thermostatic controls to the winter ventilation unit so that its heating capacity can assist in temperature recovery and night setback can be effectively implemented.

Assumptions

The technical assumptions are as follows:

- The minimum indoor temperature is set to 68°F.
- The ventilation fans were on only during non-setback hours.

- The design loss is equal to the sum of the radiator and heating unit capacities as given on the Fort drawings.
- Heating fans and pumps are operating 42 h/week during wintertime. After the equipment is installed on the time clock, operating time is 29.5 h/week.
- Summer ventilation fans are operating 42 h/week during summertime. After implementation of the measure, operating time is 29.5 h/week.

The cost estimate is as follows:

	<u>Materials</u>	<u>Labor</u>	<u>Total</u>
Design Cost	--	\$4,700	\$4,700
Construction	<u>\$30,900</u>	<u>--</u>	<u>\$30,900</u>
Totals	\$30,900	\$4,700	\$35,600

Results

The complete quantitative results of this ERO appear in Table 2.6. The table contains specific energy, cost, and economic performance data. This ERO effects the battalion headquarters buildings on New Post covering approximately 215,000 ft² of commercial floorspace.

Budget Implications. The initial cost of this ERO is \$35,600.

Energy and Cost Savings. It is estimated that this ERO will result in an annual energy savings of 3,907 MBtu at a value of \$15,780.

Operations and Maintenance. This ERO will reduce the run-time of fan motors and pumps. However, is not anticipated to significantly reduce maintenance requirements.

Energy Security Issues. Improved energy efficiency leads to reduced energy consumption, which inherently strengthens energy security.

Environmental Issues. This measure will result in reduced air pollutants associated with a reduction fuel combustion.

2.6.3 CO₂-Based Ventilation Control

Description

Ventilation control on the New Post is currently based on time-clock schedules and thermostatic control of outside air cooling. In many buildings, when ventilation is not required for free cooling, the actual quantity of fresh air needed for the current occupants is undetermined, and a minimum value is imposed by a minimum outside air damper setting. Typically, the HVAC and ventilation controls are designed to maximum occupancies, and the fresh air ventilation rate is excessive for large periods of time. This results in unnecessary heating (and in some cases cooling) of outside air during much of the year. A more accurate measure of need for fresh air is the level of CO₂ (a primary product of exhalation) in the air. The ASHRAE standard for fresh air in buildings is expressed as recommended outside air cubic feet per minute (cfm), as well as CO₂ concentration (875 parts per million [ppm] for offices [ASHRAE Standard 62-1989]).

The existing ventilation control can be modified so that the outside air damper modulates between the current minimum outside air setting to maintain a CO₂ concentration below 875 ppm. In addition, the fan schedules can be modified to reduce operating hours and to reduce hours of operation at high speed; the CO₂ control will override the schedule only when actual occupancy requires it. Energy savings will result chiefly from reduced outside air fan operation and reduced heating of excess outside air.

The primary sources of data used in this resource analysis were the building drawings, control sequences, site visit walk-throughs, demand ventilation articles from trade and academic journals, and manufacturers' literature. Estimates of excess hours of fan operation and excess outside air volume are based on existing control and operation strategies for each building type.

Assumptions

General assumptions are as follows:

- Existing outside air damper actuators have 0% and 15% outside air fraction settings.

- Actual ventilation required (based on CO₂ concentration) is, on the average, half of what is currently supplied. (This factor is applied to the average occupied hours per day and the degree-days per year to obtain degree-hours per year.)
- The difference between the outside and inside air-condition is 0.01776 Btu/ft³•°F.
- Fan flow rates were estimated from fan power assuming a static pressure of 1.5-in. WC, a fan efficiency of 0.9, and a motor loading of 75% of nameplate.
- Heating degree-days are based on Syracuse data. Adjustments (Army 1978) were made to the standard 65°F base degree-days because 1) outside temperature during the occupied part of the day is, on the average, higher than the mean daily temperature and 2) the savings in outside air load accrue all the way up to room temperature, not just to the balance point (taken to be 65°F in the standard degree-day calculation) used for annual load calculations. The adjusted monthly heating degree-days are as follows:

<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>
141	450	780	1,206	1,345	1,187	1,048	615	316

Building type specific assumptions:

- Administration (ADM) buildings each have six zones where CO₂ sensors/controllers are useful. A 50% reduction in AHU and summer ventilation volume is assumed. There are 57 ADM buildings, giving a total of 342 fans to be controlled.
- Vehicle maintenance (SHP) buildings each have four zones where CO₂ sensors/controllers are useful. The work bay areas are not included because excess CO may be present even though the CO₂ level is low. Ventilation control by CO₂ sensors is therefore used only in office/storage areas. The two-speed ventilation fans are assumed to run at low speed 90% of the time. There are 11 SHP buildings, giving a total of 44 fans to be controlled.
- Recreation (REC) facilities each have three zones where CO₂ sensors/controllers are useful. A 33% reduction in ventilation volume is assumed. There are eight REC buildings, giving a total of 24 fans to be controlled.
- Chapel and youth activity (ASS) facilities each have two zones where CO₂ sensors/controllers are useful. A 33% reduction in ventilation volume is assumed. There are four assembly buildings, giving a total of 12 fans to be controlled.

- Dining halls (MES) each have two zones (dining areas only) where CO₂ sensors are useful. A 33% reduction in ventilation air volume is assumed. Odor and moisture effects from kitchen activities are controlled by the kitchen exhaust and ventilation systems, which will not be affected by this ERO. There are seven MES buildings, giving a total of 14 fans to be controlled.

Cost estimates are based on the following material and labor elements:

- \$395 per unit (GazTech)^(a) for the sensor/control unit.
- \$100 per unit (based on thermostat installation labor, Means (1991), assuming that six units are installed per building) for labor and low-voltage wiring.

Results

The CO₂ level ventilation control was analyzed for only ADM-type buildings because these buildings have the largest zone and fan sizes and represent the largest energy savings potential for this ERO among all the building types. The characteristics, operation, and economic parameters for this ERO are presented in Table 2.7 (p. 2.68). The results are discussed below.

Budget Implications. The savings in primary heating energy are a function of the marginal price of energy purchased from the Jones Plant. The cumulative effect of all thermal loop EROs on this marginal price has not been determined and may reduce the dollar savings somewhat; however, the initial cost of this ERO is \$170,000.

Energy, Demand and Cost Savings. This ERO results in savings of both electrical (110,767 on-peak and 166,150 off-peak kWh per year) and primary heating (2,467 MBtu/yr) energy. The value of the annual energy savings is approximately \$23,309.

Energy Security. There are no significant energy security issues associated with this ERO.

Operations and Maintenance. The CO₂ sensors should be checked annually for calibration at a cost of \$25/unit. This additional maintenance effort will be largely offset by the reduced maintenance to ventilation fans and

(a) GazTech International Corp. Demand Control Ventilation. IG-1, Ventostat Model No. 1070, Product Bulletin, October 19, 1992.

outside air filters and ducts. Since filters are not 100% effective, the reduced intake of outside air will also result in less dust in the affected buildings.

Environmental Issues. There are no significant environmental issues associated with this ERO other than the environmental benefits of reduced energy use.

TABLE 2.6. HVAC System EROs

HVAC System ERO Economic Parameters

ID	ERO Type	Sector	Fuel Type	First Cost (\$)	Life (yr)	Energy Savings (MBtu/yr)	Energy and O&M Savings		Life Cycle Cost	
							Energy \$	O&M \$	NPV (\$)	Value Index
1a	FM System	Old Post	FO2	30,492	20	2,283	14,331	N/A	211,325	6.93
2a	Night Setback	New Post	HTHW	35,589	20	3,907	15,781	N/A	247,322	6.95

TABLE 2.7. CO₂ Sensor ERO in Administration (NADM Type) Buildings

Existing fan motor operating parameters (Electric)

ID	Existing Equipment			Density sqFt/mtr	Qty. per Bld	Qty. (all)	Operating Schedule			Months on-peak	% Time High Set	Energy Consumption (kWh)			Sum of 12 Monthly coincident demands (kW-m)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			on-peak	mid-peak	off-peak	on-peak	mid-peak	off-peak
1	MF-1.5	AHU Fan	1.5	12,531	1	57	800	NA	1,200	9	NA	51,026	NA	76,540	742	NA	NA
2	MF-1.5	AHU Fan	1.5	12,531	1	57	1,000	NA	1,500	9	NA	63,783	NA	95,675	742	NA	NA
7	MF-7.5/1.7	Summer Ven	7.5/1.7	4,129	3	173	680	NA	1,020	3	10	200,092	NA	300,137	3,404	NA	NA
8	MF-5/1.2	Summer Ven	5/1.2	12,531	1	57	680	NA	1,020	3	10	45,686	NA	68,528	767	NA	NA

CO2 controlled fan operating parameters (Electric)

ID	Energy Resource Opportunity			Density sqFt/mtr	Qty. per Bld	Qty. (all)	Operating Schedule			Months on-peak	% Time High Set	Energy Consumption (kWh)			Sum of 12 Monthly coincident demands (kW-m)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			on-peak	mid-peak	off-peak	on-peak	mid-peak	off-peak
1A	MCO2-1.5	AHU w/CO2	1.5	12,531	1	57	400	NA	900	9	NA	23,644	NA	35,465	742	NA	NA
2A	MCO2-1.5	AHU w/CO2	1.5	12,531	1	57	500	NA	1,125	9	NA	29,555	NA	44,332	742	NA	NA
7A	MCO2-7.5/1.7	Vent w/CO2	7.5/1.7	4,129	3	173	544	NA	816	3	10	160,073	NA	240,110	3,404	NA	NA
8A	MCO2-5/1.2	Vent w/CO2	5/1.2	12,531	1	57	544	NA	816	3	10	36,548	NA	54,823	767	NA	NA

CO2 controlled fan operating parameters (Heating)

ID	Energy Resource Opportunity			Density sqFt/mtr	Qty. per Bld	Qty. (all)	Operating Schedule			Months on-peak	% Time High Set	MBtu Savings
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			
1A	MCO2-1.5	AHU w/CO2	1.5	12,531	1	57	400	NA	600	9	NA	1,096
2A	MCO2-1.5	AHU w/CO2	1.5	12,531	1	57	500	NA	750	9	NA	1,371

CO2 controlled fan ERO economics

ID	Economic Parameters						First Year Energy & Demand Savings							Life Cycle Cost	
	RI First Cost (\$)	ROF 1st Cost (\$)	O&M (\$/yr)		Life (Yr)	Salvage (\$)	Energy (kWh)	Demand (kW-mo)	Heat (MBtu)	Energy (1992 \$)	Demand (1992 \$)	Heat (1992 \$)	Total (1992 \$)	NPV (\$)	Value Index
1A	28,215	NA	0	1,425	5	0	68,457	0	1,096	3,404	0	4,239	7,643	3,886	0.14
2A	28,215	NA	0	1,425	5	0	85,571	0	1,371	4,255	0	5,300	9,555	33,752	1.20
7A	85,635	NA	0	4,325	5	0	100,046	0	0	4,975	0	0	4,975	(280,540)	(3.28)
8A	28,215	NA	0	1,425	5	0	22,843	0	0	1,136	0	0	1,136	(99,516)	(3.53)

2.7 BUILDING LIGHTING EROs

Over 30% of the electrical energy supplied to Fort Drum is used for lighting in and around buildings. Few, if any, of the existing lamps, ballasts, and light fixtures are as efficient as currently available cost-effective lamps, ballasts, and fixtures. A number of fixture retrofit and fixture replacement EROs are therefore evaluated in this section. In many cases, energy can also be saved by installing occupancy sensors or making other control and wiring modifications that result in reduced hours of operation. In some cases, the lighting levels can be significantly reduced.

Eleven specific EROs for building interior and building exterior lighting are discussed in this section. Streetlighting EROs are discussed in Section 2.8.

Data and Assumptions Common to All Lighting EROs

Data and assumptions that pertain to individual lighting EROs are presented in the ERO analysis subsections (Sections 2.7.1 through 2.7.11). Data and assumptions that apply to most or all of the EROs are presented here for convenient reference.

For the purpose of lighting ERO analysis, the building types defined in Volume 2, Baseline Detail, were aggregated into six groups. The building types within each group have similar occupancy schedules. Housing is split into on- and off-post housing because of the different electric power rate structures. The groups are defined as follows:

- Group A: New Post Chapels and Classrooms (NASS), New Barracks (NBAR), Old Post Barracks (OBAR).
- Group B: Old & New Post Administration (OADM, NADM), Old Post Chapels and Classrooms (OASS), Old Post Communications (OCOM), Old & New Post Medical Facilities and Clinics (OMED, NMED), Old & New Shops (OSH, NSHP), Vehicle Overhaul Facility (NSMA), and the Sage Complex.
- Group C: Old and New Post Recreation (OREC, NREC), New Post Grocery (NGRO), Old and New Post Dry Goods/Retail (ODGR, NDGR).
- Group D: Old & New Post Dining (OMES, NMES), Old & New Post Clubs (OCLB, NCLB).

Group E: Off-Post Housing.

Group G: On-Post Housing.

<u>Operation Parameter</u>	<u>Building Type Group</u>					
	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>	<u>G</u>
Hours On-Peak Occupied	1,528	2,038	3,566	2,802	1,528	1,528
Hours Off-Peak Occupied	1,757	255	1,544	2,308	1,757	1,757
Percent on (occupied)	40%	63%	89%	73%	40%	40%
Hours On-Peak Unoccupied	2,038	1,528	0	764	2,038	2,038
Hours Off-Peak Unoccupied	3,437	4,939	3,650	2,886	3,437	3,437
Percent on (unoccupied)	5%	18%	12%	10%	5%	5%

- PNL Lighting Matrix. The first costs of fixture upgrades (either replacement or retrofit) that are feasible for a given type of existing fixture are determined using data from the PNL *Lighting Technology Screening Matrix* computer program (Dirks et al. 1992). The per-fixture wattage and maintenance requirements for each existing and post-retrofit configuration are also determined using the *Lighting Technology Matrix* database.
- Fixture Modification vs. Fixture Replacement. Fixtures can be upgraded by replacing selected parts (ballast, lamp, reflector, or lens) or by replacing the entire fixture. The former approach (replacement of selected parts) will be referred to as "retrofit," the latter as "replacement," and both as a fixture "upgrade." The best route for a given upgrade is generally determined by the relative costs in the *Lighting Matrix* except when site-specific (usually implementation labor or maintenance related) conditions dictate otherwise.
- Operating Hours. The hours of operation of interior lights were determined by building type group based on information gathered from the site and summarized in the following table. The "percent on" numbers indicate the average fraction of lights turned on during occupied and unoccupied hours.
- Fixture Type and Quantity. The existing fixture inventory was estimated for each building type (ADM, BAR, CLB, COM, DGR, GRO, MED, MES, etc.). While detailed information was available for some buildings from site visits or plans, the lighting in the majority of the buildings could not be rigorously established within the scope of this project. Estimates of the existing lighting stock were therefore developed in the following manner. Plans were obtained for one of each New Post prototype building (ADM, BAR, MES, SHP). For the Old Post, information was obtained by limited

walk-throughs and interviews. With this information, prototypical fixture counts for each New and Old Post building type were calculated and extrapolated to the aggregate floor area of all buildings of each type. This approach assumes that all of the buildings of a given type have the same fixture types, distribution, and use. Several building types were not included because no information was available. It is believed that the omitted buildings, as a group, represent a relatively small fraction of the total lighting energy. Thus, the numbers in the accompanying tables are not exact but are believed to reasonably characterize existing lighting on the site and the potential for efficiency improvements with available technologies.

- Existing Ballasts. The ballasts used in all existing fluorescent fixtures are standard 60-Hz inductive ballasts.
- Light Levels. Existing light levels are adequate or more than adequate for the visual activities conducted in a space unless otherwise noted. The retrofit fixtures will provide the same lighting level, or slightly less, and are, in all cases, intended to meet or exceed minimum applicable federal standards. The lumen equivalence of replacement fixtures or retrofit packages cannot be determined exactly from the nominal fixture characteristics due to variations in fixture design and the lighting environment and task requirements. The ability of a given upgrade to provide adequate level and quality of light should be field-checked in typical applications before proceeding with a large-scale retrofit.
- Salvage Value. The salvage value for used fixtures is small at best and has been assumed to be zero. Actual salvage value will be reflected in the cost proposals of competitive energy services contractor (ESCO) bidders. It is essential to the project's long-term success that the old fixtures be removed from the site to prevent their being re-installed for any reason and the inefficient use of electric power that would result.
- Maintenance Costs. Maintenance cost savings are expressed as annualized values. Relamping costs that might occur every 5 years in the 25-year life of an ERO are converted to a present value, and the present value is then converted to a uniform series of yearly costs. Maintenance savings are due chiefly to longer lamp lives (e.g., HPS and fluorescent lamps have a much longer life than standard incandescent) that result in lower annual lamp replacement costs. In cases where the retrofit maintenance cost is only slightly less than the existing maintenance cost, the savings are taken to be zero. This results in a slightly conservative assessment of NPV and resource potential.
- Penetration of EROs. Unless otherwise stated, all feasible retrofits (100% penetration) are assumed to be implemented in the resource assessments for each ERO.

Non-Energy Effects Common to All ERO Implementations

Except in the few cases where additional impacts will be explicitly mentioned, the following statements of maintenance, energy security, and environmental impact apply.

- Operations and Maintenance. The replacement or retrofit of incandescent fixtures results in reduced maintenance. Delamping also results in reduced maintenance. All other EROs result in post-retrofit maintenance requirements that are identical or nearly identical to the existing maintenance requirements.

All non-energy O&M costs are reported as annualized values based on all major maintenance costs over the analysis period of 25 years. The operation of lighting systems will not be adversely affected by implementation of any of the EROs. An additional unmeasured benefit of the fixture replacement and retrofit EROs is that conversion to standard lighting systems over the entire site may eliminate the need to have multiple types of tubes, ballasts, etc., on hand for repair or replacement.

- Annualized O&M costs as reported in tables are dependent on the operating characteristics (hours of operation) of the lights being impacted. Therefore, the same fixture type may have a different annualized O&M cost from one table to the next, based on its hours of operation.
- Energy Security. None of the lighting EROs have significant impact on energy security.
- Environmental Impact. There are no negative environmental impacts associated with any of the lighting EROs, with the possible exception of the fluorescent fixture upgrades that will involve ballast disposal. In general, implementing lighting EROs will decrease the need for electricity that may be produced from sources that have environmental impacts. All lighting EROs are environmentally beneficial in this respect.

Table Formats

The results of the energy and economic analysis are presented in Tables 2.8 through 2.10 (see p. 2.99). The life-cycle cost is computed two ways for each retrofit: with no rebate and with a 50% rebate. In some cases, the optimal retrofit for the no rebate case differs from the retrofit for the 50% rebate case. When this happens, the 50% rebate retrofit is indicated in the body of the table and the no-rebate retrofit is indicated by a footnote.

The results for large room occupancy sensor EROs are reported for the three possible combinations of fixture and occupancy sensor measures: retrofit only, fixture retrofit with occupancy sensor, and occupancy sensor only. The results for each combined measure are reported in a block of successive rows covering all fixture types that occur in rooms eligible for occupancy sensors. Within each block the results for a given fixture type are reported on two successive lines. The first line indicates the operating parameters for the quantity of fixtures in rooms that are not eligible for occupancy sensors, and the second line indicates the operating parameters for fixtures in rooms that are eligible. The combined NPV (for the pair of lines) determined which combination of fixture and occupancy sensor retrofit is optimal. Note that for a given existing fixture, the PNL Lighting Matrix (Dirks et al. 1992) can find different optimal fixture retrofits for the fixture upgrade only and fixture and occupancy sensor cases.

The results for small room occupancy sensors have been presented differently because of the sensitivity of the outcome to 1) connected load per sensor and 2) cost uncertainties. The occupancy sensor zones have been enumerated by fixture type and number of fixtures to reduce errors due to the first sensitivity and facilitate reassessment (to reduce errors due to the second sensitivity) by ESCOs based on their costs. Only one outcome is reported per fixture type and number-per-zone enumeration, because there is only one best combination of fixture retrofit and occupancy sensor for each enumeration.

2.7.1 Upgrade Fluorescent Lighting in Commercial Buildings

Description

This ERO consists of replacing or retrofitting most of the four- and eight-foot fluorescent fixtures in New Post and Old Post commercial buildings. In some cases the existing fixture can be modified to accept the new tubes, ballast, and reflector. In other cases, due to fixture type, age, etc., the entire fixture must be replaced.

The selected retrofit is a T-8 system that includes a T-8 high-efficiency lamp, an electronic T-8 ballast, and a specular reflector.

Assumptions

In addition to the general assumptions stated at the beginning of Section 2.6, the following technical assumptions apply:

The existing fixtures and their replacements are as follows:

<u>Existing Fixture Description</u>	<u>Number of Fixtures</u>	<u>Replace or Retrofit</u>	<u>ERO Description</u>
2 x 4 6F40	883	Retrofit	2-tube T-8 system
2 x 4 4F40	907	Retrofit	2-tube T-8 system
2 x 4 3F40	106	Replace	FL 2 x 4 2-40 ELC REF
2 x 4 2F40	68	Retrofit	2-tube T-8 system, no REF
2 x 4 4F34	20,110	Retrofit	2-tube T-8 system
2 x 4 3F34	8,626	Replace	2-tube T-8 system
2 x 4 2F34	15,658	Retrofit	2-tube T-8 system, no REF
1 x 4 2F40	2,407	Replace	FL 1 x 4 1-40 ELC REF
1 x 4 1F40	2,214	Retrofit	1-tube T-8 system, no REF
1 x 4 2F34	3,353	Replace	FL 1 x 4 1-34 ELC REF
1 x 4 2F34 WP	1,532	Replace	FL 1 x 4 1-34 ELC REF
6" x 4 1F40	1,334	Retrofit	1-tube T-8 system, no REF
6" x 4 2F40	214	Replace	FL 6" x 4 1-40 ELC REF
6" x 4 1F34	2,918	Retrofit	1-tube T-8 system
1 x 8 2F96 (75 W)	821	Retrofit	1 x 8 2F96 (75 W) ELC

Cost estimates are based on the following standard costs taken from the PNL *Lighting Matrix* (Dirks et al. 1992):

<u>ERO Item Description</u>	<u>Installation Material and Labor (\$)</u>	<u>Annualized O&M Cost (\$/yr)</u>
Replace w/2 tube T-8 system	155	2.86
Retrofit w/2 tube T-8 system	102	0.94
Replace w/1 tube T-8 system	120	0.30
Retrofit w/1 tube T-8 system	47	0.78
Retrofit w/2-tube F96 ELC	70	3.12
Retrofit w/2-tube F60 ELC REF	139	3.01
Replace w/2x4 2-40 ELC REF	67.5	1.63
Replace w/2x4 T-8	52.44	0.91
Replace w/1x4 1-40 ELC REF	120	2.85

Results

The quantitative results of this lighting ERO assessment appear in Tables 2.8 through 2.11. The fluorescent upgrades are identified by fixture codes 1 through 16 and 50. The table contains specific energy, cost, and economic evaluation information for each fixture type or lighting consumption area included in the ERO.

Budget Implications. The total first cost of implementing the ERO for 61,339 fixtures is estimated to be \$3,581,851. This includes the installation and/or replacement of all necessary equipment and materials and associated labor.

Energy, Demand, and Cost Savings. The electric energy savings associated with the ERO are estimated to be 8,735,400 kWh per year at a cost savings of \$455,622. Demand savings are estimated to be 24,307 kW per year with a cost savings of \$133,931. These estimates are based on 100% implementation of the ERO for a typical operating year.

Operations and Maintenance Impacts. Maintenance cost savings for this ERO are estimated to be \$105,327 per year. It is recommended that T-8 retrofit parts and replacement fixtures be stocked in sufficient quantity to replace the existing fixtures of the type covered in this ERO but not upgraded in this implementation as their lamps, ballasts or other hardware fail. This

will eliminate the need to stock the variety of lamps and ballasts used in the older systems and will result in all fixtures eventually being upgraded with a minimal administrative effort.

Energy Security. The security of energy supply and distribution to Fort Drum will not be affected by implementation of this ERO.

Environmental Issues. In general, the implementation of this ERO will decrease the need for electricity that may be produced from sources that have environmental impacts. The disposal of PCB-bearing ballasts may, however, have to be addressed, as it is not known how many, if any, PCB-type ballasts exist at Fort Drum. If virtually all fluorescent ballasts are targeted for replacement as recommended in this ERO, the beneficial side effect will be the proper disposal of all offending ballasts. Disposal costs are about \$6 per ballast in quantities of 100.

2.7.2 Replace Large Incandescent with Compact Fluorescent and High Pressure Sodium Fixtures in Old Post Warehouse and Vehicle Maintenance

Description

Many of the Old Post warehouse and storage areas have old lighting systems consisting of 100-W, 150-W and 200-W incandescent lamps. This ERO considers replacement of the incandescent fixtures with 30 W compact fluorescent, 35-W and 50-W high-pressure sodium (HPS) fixtures. The low wattage of the replacements allows a direct one-to-one replacement of the existing fixtures without the time and expense of redesigning the lighting layout.

Assumptions

In addition to the general assumptions stated at the beginning of Section 2.6, the technical data pertinent to the analysis of this ERO are as follows:

- The existing fixtures and corresponding ERO replacements are as follows:

<u>Existing Fixture Description</u>	<u>Number of Fixtures</u>	<u>Replace or Retrofit</u>	<u>ERO Description</u>
INC 100 W pendant	23	Replace	CFL 2-15 CEIL
INC 150 W pendant	1,119	Replace	35 W HPS
INC 200 W pendant	536	Replace	50 W HPS

- The ceiling height in the replacement locations is high enough (9 to 10 ft minimum) to allow safe installation of HPS fixtures.
- It is assumed that most areas or buildings affected by this ERO do not operate on a schedule of repeated short-term access. If this is the case, the area may require a combination of HPS and incandescent (or fluorescent) technologies, because HPS lamps have a "warmup" period of several minutes before full light output is attained.

Cost estimates are based on the following standard costs taken from the PNL *Lighting Matrix* (Dirks et al. 1992):

<u>ERO Item Description</u>	<u>Installation Material and Labor (\$)</u>	<u>Annualized O&M Cost (\$/yr)</u>
Replace w/35-W HPS fixture	109	13
Replace w/50-W HPS fixture	111	11
Replace w/CFL 2-15 CEIL	65.61	11.35

Results

The quantitative results of this lighting ERO assessment appear in Table 2.9. The table contains specific energy, cost, and economic evaluation information for each fixture type or lighting consumption area included in the ERO.

Budget Implications. The total first cost of implementing the ERO is estimated to be \$182,976. This includes the installation and/or replacement of all necessary equipment and materials and associated labor.

Energy, Demand, and Cost Savings. The electric energy savings associated with the ERO are estimated to be 456,070 kWh per year at a cost savings

of \$23,987. Demand savings are estimated to be 1,313 kW per year with a cost savings of \$7,234. These estimates are based on 100% implementation of the ERO for a typical operating year.

Operations and Maintenance Impacts. Maintenance cost savings for this ERO are estimated to be \$6,954 higher per year.

2.7.3 Replace Mercury Vapor with High-Pressure Sodium in New Post Retail Stock Rooms

Description

The storage areas in the Post Exchange on the New Post have mercury vapor lighting. While the existing mercury vapor lights are more efficient than incandescent, high-pressure sodium (HPS) lights are still more than twice as efficient as mercury vapor lights. Thus, it is possible to replace each 100-W mercury vapor fixture with a 50-W high-pressure sodium fixture without changing the fixture layout or wiring.

Assumptions

In addition to the general assumptions stated at the beginning of Section 2.7, the following technical data pertain to the analysis of this ERO:

- The existing lighting stock and replacement schedule is as follows:

<u>Existing Fixture</u>	<u>Number of Fixtures</u>	<u>Replace or Retrofit</u>	<u>ERO Description</u>
100-W Merc	130	Replace	50 W HPS

- The ceiling height in the replacement locations is high enough to allow safe installation of HPS fixtures (9 to 10 ft minimum).
- The shift from blue-green color of the mercury lamps to the orange-yellow of the HPS lamps will not adversely affect operations.

Cost estimates are based on the following standard costs taken from the PNL *Lighting Matrix* (Dirks et al. 1992):

<u>ERO Item Description</u>	<u>Installation Material and Labor (\$)</u>	<u>Annualized O&M Cost (\$/yr)</u>
Replace w/50- W HPS fixture	153	9.40

Results

Quantitative results of the analysis of this lighting ERO are presented in Table 2.10. The table contains specific energy and cost estimates for each fixture type or lighting consumption area included in the ERO.

Budget Implications. The total first cost of implementing the ERO is estimated to be \$19,890. This includes the installation and/or replacement of all necessary equipment and materials and associated labor.

Energy, Demand, and Cost Savings. The electric energy savings associated with the ERO are estimated to be 33,057 kWh per year at a cost savings of \$1,759. Demand savings are estimated to be 71 kW per year with a cost savings of \$390. These estimates are based on 100% implementation of the ERO for a typical operating year.

Operations and Maintenance Impacts. Maintenance cost savings for this ERO are estimated to be \$10 per year.

2.7.4 Replace Exit Lights with Light Emitting Diode (LED) Fixtures in Commercial Buildings

Description

The existing exit lights at Fort Drum are a mix of incandescent and compact fluorescent technologies. While the compact fluorescent fixtures are relatively efficient, LED fixtures are much more efficient. In addition, the LED lamps last longer, thus saving on maintenance labor and material costs.

Assumptions

In addition to the general assumptions stated at the beginning of Section 2.6, the following technical assumptions apply.

- The inventory of existing fixtures and feasible replacements is as follows:

<u>Existing Fixture</u>	<u>Number of Fixtures</u>	<u>Replace or Retrofit</u>	<u>ERO Description</u>
EXIT INC (2 x 15 W)	918	Replace	EXIT LED
EXIT INC (2 x 20 W)	2,374	Replace	EXIT LED
EXIT 2 x PL9	500	Replace	EXIT LED

- Instead of the hours described in the general assumptions, exit lights are assumed to be on 24 hours a day, 365 days a year, as follows: weekdays, 14 hours on-peak, 10 hours off-peak, weekends, 24 hours off-peak.

Cost estimates are based on the following standard costs taken from the PNL *Lighting Matrix* (Dirks et al. 1992):

<u>ERO Item Description</u>	<u>Installation Material and Labor (\$)</u>	<u>Annualized O&M Cost (\$/yr)</u>
Replace w/LED exit fixtures	140	0

Results

The quantitative results of this lighting ERO assessment appear in Table 2.8 through 2.11. The line-item ERO involving exits signs are identified by fixture codes 45, 46, and 47. The table contains specific energy, cost, and economic evaluation information for each fixture type or lighting consumption area included in the ERO.

Budget Implications. The total first cost of implementing the ERO is estimated to be \$530,740. This includes the installation and/or replacement of all necessary equipment and materials and associated labor.

Energy, Demand, and Cost Savings. The electric energy savings associated with the ERO are estimated to be 1,010,180 kWh per year at a cost savings of \$50,308. Demand savings are estimated to be 706 kW per year with a cost savings of \$3,889. These estimates are based on 100% implementation of the ERO for a typical operating year.

Operations and Maintenance Impacts. Maintenance cost savings for this ERO are estimated to be \$148,735 per year. These savings are due to the very

long element life of the LED unit. The savings in bulb replacement labor and material costs alone makes the LED exit light the most life-cycle cost-effective technology available.

Energy Security. The security of energy supply and distribution to Fort Drum will not be affected by implementing this ERO.

Environmental Issue. In general, implementing this ERO will decrease the need for electricity that may be produced from sources that have environmental impacts.

2.7.5 Upgrade Interior Incandescent with Compact Fluorescent in Commercial Buildings

Description

This ERO consists of retrofitting or replacing most of the interior incandescent fixtures in New Post and Old Post commercial buildings with compact fluorescent fixtures. Compact fluorescent systems offer similar light quality (IES 1981) at substantial energy savings. A variety of compact fluorescent systems exist on the market today. A retrofit kit that uses a "hard-wired" ballast/socket element is preferable to a screw-in ballast/socket because it eliminates the old incandescent lamp socket, reducing material costs and ensuring the continued use (and savings) of compact fluorescent technology at lamp replacement time; it may also reduce the incidence of theft.

Assumptions

In addition to the general assumptions stated at the beginning of Section 2.6, the technical data pertaining to this ERO are as follows:

- The existing lighting stock consists primarily of ceiling fixtures. The compact fluorescent replacements are one- or two-lamp kits using 9- or 13-watt lamps. The fixture quantities and compact fluorescent replacement types are enumerated below for each existing fixture type:

<u>Existing Fixture</u>	<u>Number of Fixtures</u>	<u>Replace or Retrofit</u>	<u>ERO Description</u>
INC 60 W ceiling, surface	972	Retrofit	1 x PL-11 or 13 ^(a)
INC 2 x 60 ceiling, surface	3,660	Retrofit	2 x PL-11 or 13
INC 2 x 75 W	7,443	Retrofit	2 x PL-13
INC 75 W ceiling, recessed	2,667	Retrofit	2 x PL-9
INC 100 W ceiling, recessed	148	Retrofit	2 x PL-9
INC 150 W ceiling, recessed	76	Retrofit	2 x PL-13

(a) Lowest watt bulb that provides illumination required for the application by Army design standards must be determined at the time of installation.

Cost estimates are based on the following standard costs taken from the PNL *Lighting Matrix* (Dirks et al. 1992):

<u>ERO Item Description</u>	<u>Installation Material and Labor (\$)</u>	<u>Annualized O&M Cost (\$/yr)</u>
Retrofit with 2 x PL-13	69.00	6.20
Retrofit with 2 x PL-9	59.00	3.60
Retrofit with PL-11	21.00	6.20
Retrofit with 2 x PL-11	66.00	11.60

Results

The quantitative result of this lighting ERO assessment appears in Tables 2.8 through 2.11. The table contains specific energy, cost, and economic evaluation information for each fixture type or lighting consumption area included in the ERO.

Budget Implications. The total first cost of implementing the ERO is estimated to be \$983,914. This includes the installation and/or replacement of all necessary equipment and materials and associated labor.

Energy, Demand, and Cost Savings. The electric energy savings associated with the ERO are estimated to be 2,339,366 kWh per year at a cost savings of \$118,638. Demand savings are estimated to be 6,865 kW per year with a

cost savings of \$37,828. These estimates are based on 100% implementation of the ERO for a typical operating year.

Operations and Maintenance Impacts. Maintenance cost savings for this ERO are estimated to be \$64,000 per year. This value represents savings if the lamps are replaced by Fort personnel and not occupants.

2.7.6 Rezone Control of New Post Maintenance Shop Exterior Lighting

Excessive light levels were observed around the New Post vehicle maintenance shops during site visits at night. The maintenance shops are one/two story (high bay) structures that typically are surrounded by parking and driveway space and security fencing. The building wall exteriors are illuminated by one to three HPS wall mounted fixtures on each side of each building wing. Additional HPS wall fixtures are mounted above each high bay door (typically 9 to 20 per building). The parking and driveway area lights provide additional illumination of the building wall surfaces. Currently, all of these lights remain on throughout the night and provide greater illumination than is normally considered necessary at a commercial building.

Description

This measure consists of rewiring at least two-thirds of the bay door lights to operate only when the interior bay lights are on and the existing exterior lighting time clock is in night mode. The lights will continue to be disabled during daylight hours by the clock. The interior bay light connection will result in exterior bay door lights remaining off during most night hours as well. For night operations, bay door lighting would be manually actuated for only those bays actually in use. The remaining wall and parking lot lights should provide adequate security when the building is unoccupied at night.

Assumptions

In addition to the general assumptions stated at the beginning of Section 2.6, the following technical data are also pertinent to this ERO:

- The existing lighting stock targeted by this ERO is distributed as follows:

<u>Existing Fixture Description</u>	<u>Number of Fixtures</u>	<u>ERO Description</u>
100 W HPS Ext wall-mounted	277	Install wall switch at door
400 W HPS Ext wall-mounted	233	Install wall switch at door

- Instead of the operating hours shown in the general assumptions outlined at the beginning of Section 2.6, exterior lighting is assumed on for an average of 12 hours per day, every day, as follows: weekdays, 2 hours on-peak (8-10 pm), 10 hours off-peak (10 pm to 8 am), weekends, 12 hours off-peak.
- The lighting circuits can be easily modified at each bay door by installing a relay or replacing the single-pole bay light switch with a double pole switch.

Cost elements, based on data from *Electrical Cost Data* (Means 1991), are given below.

<u>ERO Item Description</u>	<u>Material Cost (\$)</u>	<u>Labor Cost (\$)</u>	<u>Installation Material and Labor (\$)</u>	<u>Annualized O&M Cost (\$/yr)</u>
Rewire and modify wall switch	15	60	75	0

Results

Quantitative results of the analysis of this lighting ERO are presented in Table 2.9. The table contains specific energy, cost, and economic evaluation information for each fixture type or lighting consumption area included in the ERO.

Budget Implications. The total first cost of implementing the ERO is estimated to be \$38,250. This includes the installation and/or replacement of all necessary equipment and materials and associated labor.

Energy, Demand, and Cost Savings. The electric energy savings associated with the ERO are estimated to be 589,402 kWh per year at a cost savings of \$26,714. Demand savings are estimated to be 1,386 kW per year with a cost savings of \$7,636. These estimates are based on 100% implementation of the ERO for a typical operating year.

Operations and Maintenance. Maintenance cost savings for this ERO are taken to be \$5,505 per year due to the reduced lamp replacement rate.

Mission. Although it appears that sufficient security would be provided by the remaining wall lighting, the perceived reduction in security lighting may still be an issue. A scheme that will increase security capability but retain the estimated savings of this ERO is the addition of motion-triggered lighting at strategic building points. These units would consume virtually no power unless activated by motion. In this manner, additional light would be provided automatically whenever personnel, vehicles, etc., are in the area.

2.7.7 Upgrade Exterior Entry Incandescent Downlights with Compact Fluorescent in New Post Commercial Buildings

Description

Many of the buildings on the New Post have incandescent lights positioned outside over the doorways to provide security and safety at night. Since these lights are on the same circuit as the other security lighting, there is a great opportunity for savings in retrofitting them with compact fluorescent lamps. Cold weather retrofit "kits" must be used to ensure that the lights will operate during the winter.

A retrofit kit involving a "hard-wired" ballast/socket element is preferable to a screw-in ballast/socket because it eliminates the old incandescent lamp socket. This ensures the continued use (and savings) of compact fluorescent technology at lamp replacement and may reduce the incidence of theft.

Assumptions

In addition to the general assumptions stated at the beginning of Section 2.6, the following technical assumptions apply.

- The existing lighting stock consists entirely of ceiling fixtures. The direct compact fluorescent replacements are two-lamp kits using 9-watt lamps and one-lamp kits using a 13-watt lamp. The quantity of each existing fixture type and the type of compact fluorescent kit that will be used to convert each existing fixture are enumerated below:

<u>Existing Fixture Description</u>	<u>Number of Fixtures</u>	<u>Replace or Retrofit</u>	<u>ERO Description</u>
INC 75-W surface mount (ext)	101	Retrofit	2 x PL-9
INC 75-W can (ext)	409	Retrofit	1 x PL-13

- Instead of the operating hours shown in the general assumptions at the beginning of Section 2.6, exterior lighting is assumed on for an average of 12 hours per day, every day, as follows. weekdays: 2 hours on-peak (8-10 pm), 10 hours off-peak (10 pm to 8 am); weekends: 12 hours off-peak.

Cost estimates are based on the following standard cost elements taken from the PNL *Lighting Matrix* (Dirks et al. 1992):

<u>ERO Item Description</u>	<u>Installation Material and Labor (\$)</u>	<u>Annualized O&M Cost (\$/yr)</u>
Retrofit with 2 x PL-9	59.00	3.60
Retrofit with 1 x PL-13	46.00	7.51

Results

The quantitative results of this lighting ERO assessment appear in Table 2.9, fixture code 52, and Table 2.10, fixture code 51. The table contains specific energy and cost data for each fixture type or lighting consumption area included in the ERO.

Budget Implications. The total first cost of implementing the ERO is estimated to be \$21,728. This includes the installation and/or replacement of all necessary equipment and materials and associated labor.

Energy, Demand, and Cost Savings. The electric energy savings associated with the ERO are estimated to be 123,788 kWh per year at a cost savings of \$5,642. Demand savings are estimated to be 351 kW per year with a cost savings of \$1,262. These estimates are based on 100% implementation of the ERO for a typical operating year.

Operations and Maintenance Impacts. Maintenance cost savings for this ERO are estimated to be \$3,373 per year.

2.7.8 Occupancy Sensors in Large Rooms of New Post Commercial Buildings

Description

In many work spaces (offices, stock rooms, work bays, etc.), lights are left on all day. Often lights are left on by occupants who plan on being gone only for a few minutes or want to assure others that they are "in." It is well established that a net savings will accrue any time that incandescent or fluorescent lights can be turned off for more than a fraction of a minute.^(a) The long-term costs of reduced lamp, ballast, and switch life are more than offset by the accumulated energy savings.

The control of interior lighting by occupancy sensors will reduce energy consumption in the prototypical New Post buildings analyzed here. One-of-a-kind buildings may also represent a significant potential for savings by occupancy sensors but are not included in the analysis due to lack of data.

Wall (switch plate)- or ceiling-mounted sensors are considered, depending on the type, size, and application of the room or space. Occupancy-sensing switches are designed to detect occupant motion typical of the office environment but they can be adjusted for sensitivity and turn-off delay time to ensure proper performance in almost any work area.

Assumptions

- Rooms or lighting zones with at least eight 34 watt (or 272 watt equivalent) fluorescent fixtures are considered here because the outcome of the analysis relatively insensitive to the connected load above this threshold. Smaller connected loads are treated on a case-by-case basis in Section 2.6.9.
- The energy savings are based on the average percent of time that the lights are left on when no one is in the room. The estimated percent savings in on-peak energy use are as follows: Admin/Office 25%, Chapel 20%, Dining Hall 15%, Vehicle Maintenance 25%, Barracks 20%, and Dental Clinic 25%. The average percent reduction in monthly demand is equal to the percent savings in on-peak energy use. (The potential demand reduction is probably larger than assumed, due to the effectiveness of occupancy sensors in reducing

(a) NCEL, "Turn off the lights," (energy) Tech Data Sheet 80-01 by William Pierpoint, Naval Civil Engineering Laboratory, Port Hueneme, CA 93043 (Jan. 1980).

load over the noon hour—currently the time of peak 15-minute base-wide load in most months.) The savings during unoccupied hours are taken to be zero because there is little unoccupied period use, and our site visit observations indicate that occupants are conscientious about turning light out when they leave for the day.

- The existing fixtures targeted by this ERO are distributed as follows:

<u>Fixture Location/Type</u>	<u>Wall Sensors</u>		<u>Ceiling sensors</u>	
	<u>Number of Sensors</u>	<u>Fixtures Controlled</u>	<u>Number of Sensors</u>	<u>Fixtures Controlled</u>
<u>Admin/Office</u>				
2 x 4 3F34	234	1,058	234	3,858
1 x 4 2F34	58	234	0	0
<u>Chapel</u>				
2 x 4 3F34	0	0	4	25
<u>Dining Hall</u>				
2 x 4 4F34	0	0	22	194
2 x 4 3F34	0	0	43	582
1 x 4 2F34	0	0	43	1,165
<u>Veh.Mnt.Shops</u>				
1 x 4 2F40	0	0	84	504
2 x 4 3F34	63	336	63	735
2 x 4 4F34	42	168	0	0
<u>Barracks</u>				
2 x 4 2F34	259	1,554	0	0
1 x 4 2F34	104	622	0	0
<u>Dental Clinic</u>				
2 x 4 6F40	80	306	0	0

Cost data were derived from manufacturers' and distributors' literature and from Means (1991). The cost elements used in the analysis are as follows:

<u>ERO Item Description</u>	<u>Material Cost(\$)</u>	<u>Labor Cost(\$)</u>	<u>Installation Total(\$)</u>	<u>Annualized O&M Cost (\$/yr)</u>
Wall-mounted Sensor	60	8	68	0
Ceiling-mounted Sensor	100	85	185	0

Results

The quantitative results of this lighting ERO assessment appear in Tables 2.8, 2.9, and 2.11. The table contains specific energy, cost, and economic evaluation information for each fixture type or lighting consumption area included in the ERO. Many of the fixtures targeted for occupancy sensors are also included in Section 2.6.1, which covers upgrading the existing fluorescent fixtures. Therefore, results are shown for all three possibilities: occupancy sensor alone, fixture upgrade alone, or fixture upgrade with occupancy sensor.

Budget Implications. The total first cost of implementing the ERO is estimated to be \$1,390,125. This includes the installation and/or replacement of all necessary equipment and materials and associated labor.

Energy, Demand, and Cost Savings. The electric energy savings associated with the ERO are estimated to be 4,001,049 kWh per year at a cost savings of \$211,690. Demand savings are estimated to be 12,176 kW per year with a cost savings of \$67,090. These estimates are based on 100% implementation of the ERO for a typical operating year.

Operations and Maintenance Impacts. Maintenance cost savings for this ERO are estimated to be \$47,512 per year due to reduced lamp replacement.

2.7.9 Occupancy Sensors in Small Offices, Dayrooms and Restrooms

Description

This ERO consists of installing occupancy sensors in small offices and restrooms on both the new and old post, and a barracks dayrooms on the old post. These rooms typically have one or two fixtures with 2 to 4 tubes each. (See Section 2.6.8 for further descriptive information on occupancy sensors.)

Assumptions

- Occupancy sensors will be wall-mounted replacements for the existing wall switch in offices and dayrooms. In restrooms, ceiling mounted sensors will be used to ensure adequate coverage of the area, and wall switches will be removed or disconnected.
- The following tables describe the assumptions for the hours of operation for both the existing and retrofit calculations. These numbers were provided by Steve Rowley at Fort Drum, based on his estimates of hours of operation and potential savings. These savings assume the use of sensors with Auto-Off switches rather than On-Auto-Off switches.

New Post Small Offices

	<u>Existing</u>	<u>ERO</u>
Hours per Day (On-Peak)	8.5	4
Days per Week	5	5
Weeks per Year	50	50
<hr/>		
Annual On-Peak Hours	2,125	1,000
Annual Off-Peak Hours	0	0

Administration Building Restrooms

	<u>Existing</u>	<u>ERO</u>
Hours per Day (On-Peak)	9	5
Hours per Day (Off-Peak)	1	0.5
Days per Week	5	5
Weeks per Year	50	50
Nights per Year Lights Left On	12	0
Weekends per Year Lights Left On	6	0
<hr/>		
Annual On-Peak Hours	2,340	1,250
Annual Off-Peak Hours	718	125

Old Post Small Offices

	<u>Existing</u>	<u>ERO</u>
Hours per Day (On-Peak)	9	5
Days per Week	5	5
Weeks per Year	50	50
<hr/>		
Annual On-Peak Hours	2,250	1,250
Annual Off-Peak Hours	0	0

Old Post Barracks Dayrooms

	<u>Existing</u>	<u>ERO</u>
Hours per Day (On-Peak)	13	9.6
Hours per Day (Off-Peak)	1	0.4
Days per Week	7	7
Weeks per Year	52	52
Nights per Year Lights Left On	1	0
Annual On-Peak Hours	4,733	3,484
Annual Off-Peak Hours	374	156

Old Post Barracks Restrooms

	<u>Existing</u>	<u>ERO</u>
Hours per Day (On-Peak)	9	6.9
Hours per Day (Off-Peak)	1.4	0.3
Days per Week	7	7
Weeks per Year	52	52
Nights per Year Lights Left On	1	0
Annual On-Peak Hours	3,571	2,527
Annual Off-Peak Hours	520	94

- **Fixture Counts:** The number of rooms and fixtures on the new post was estimated based on counts from prototypical building plans. Room and fixture counts for a chapel (P-4405), dining hall (P-10650), company HQ (counts based on administration parts of barracks P-10644, P-10642, P-10632, and P-10622), brigade HQ (P-10500), and battalion HQ (P-10640) were obtained from the plans. The number and floor areas of similar buildings of each type were determined. The fixture and room counts were multiplied by this number to estimate the total fixtures controlled and the total number of sensors to be installed in each building type.

There are four building types on the old post under consideration for occupancy sensors: single-story administration, two-story administration, barracks, and shops. Information about the number and type of fixtures was provided by Steve Rowley as follows:

Two-story admin: 16 small office spaces with two 4F34 fixtures per space.
 2 restrooms with one 4F34 fixture.
 1 conference/breakroom with three 4F34 fixtures.

One-story admin: 5 small office spaces with two 4F34 fixtures per space.
 1 restroom with one 4F34 fixture.

Shops: 2 small office spaces with two 4F34 fixtures per space.
 1 restroom with one 4F34 fixture.

Barracks: 1 dayroom with two 4F34 fixtures.
 1 restroom with two 4F34 fixtures.

The number of Old Post administration, barracks, and shop buildings was found on the facility list (FACLIST.WK1) provided by Fort Drum. The facility list has no information as to the number of floors per building. A count of the buildings showed 236 administration buildings with 70 different floor areas. It was assumed that all of the administration buildings over 3,500 ft² (except Bldg. 15) were two stories, as detailed below:

Single-Story Admin.	(<3,500 ft ²)	: 80 Bldgs,
	Average ft ²	: 1,823 ft ²
	Median ft ²	: 1,675 ft ²
Two-Story Admin.	(>3,500 ft ²)	: 56 Bldgs,
	Average ft ²	: 5,935 ft ²
	Median ft ²	: 4,720 ft ²

- Other old and new post building types were not considered because the aggregate floor area of rooms that serve office and restroom functions in the other types is relatively small.
- The existing fixtures targeted by this ERO are distributed as shown in the following table.

ID	Fixture Type	No. Rooms/ Sensors	No. of Fixtures	Room Type
	New Post Chapel	4 Buildings		
7a	2F34	60	2	Office
7c	2F343	12	1	Office
23	2 x 60W	8	2	Restroom
	New Post Dining Hall	6 Buildings		
7c	2F34	12	1	Office
7a	2F34	12	2	Office
6a	3F34	6	4	Office
6d	3F34	24	1	Restroom
	New Post Barracks/Admin.	24 Buildings		
6c	3F34	244	2	Office
6b	3F34	183	3	Office
6a	3F34	85	4	Office
7b	2F34	122	2	Restroom

<u>ID</u>	<u>Fixture Type</u>	<u>No. Rooms/ Sensors</u>	<u>No. of Fixtures</u>	<u>Room Type</u>
New Post w/LRC		4 Buildings		
6c	3F34	56	2	Office
5e	4F34	16	2	Office
6b	3F34	4	3	Office
7a	2F34	4	2	Office
7b	2F34	8	2	Restroom
New Post BN HQ w/Clrm		14 Buildings		
6c	3F34	168	2	Office
6b	3F34	28	3	Office
5e	4F34	14	2	Office
7b	2F34	28	2	Restroom
Old Post Single-Story Admin.		180 Buildings		
5c	4F34	900	2	Office
5d	4F34	180	1	Restroom
Old Post Two-Story Admin.		56 Buildings		
5c	4F34	896	2	Office
5d	4F34	112	1	Restroom
5f	4F34	56	3	CO/Break
Old Post Barracks		163 Buildings		
5a	4F34	180	2	Dayroom
5b	4F34	180	2	Restroom
Old Post Shops		37 Buildings		
5c	4F34	74	2	Office
5d	4F34	37	1	Restroom

- Demand savings are based on an assumed 25% reduction in on-peak demand.
- See Section 2.7.8 for assumptions on cost data.

Results

The quantitative results of this lighting ERO assessment appear in Table 2.13 (p. 2.106). This table contains specific energy, cost, and economic evaluation information for each fixture type or lighting consumption area included in the ERO. Many of the fixtures targeted for occupancy sensors are also included in Section 2.7.1, which covers upgrading the existing fluorescent fixtures to a T-8 system.

Budget Implications. The total first cost of implementing the ERO is estimated to be \$297,630. This includes the installation and/or replacement of all necessary equipment and materials and associated labor.

Energy, Demand, and Cost Savings. The electric energy savings associated with this ERO are estimated to be 1,250,280 kWh per year at a cost savings of \$72,047. Demand savings are estimated to be 3,182 kW-months at a cost savings of \$17,532. These estimates are based on 100% implementation of the ERO for a typical operating year.

Operations and Maintenance Impacts. Maintenance cost savings for this ERO are estimated to be \$24,017 per year due to reduced lamp and ballast replacement.

2.7.10 Upgrade Fluorescent Lighting in Family Housing

Description

This ERO consists of replacing or retrofitting all of the four-foot fluorescent fixtures in family housing structures on both the on-post and off-post areas with T-8 system fixtures or retrofits. The system includes a T-8 high-efficiency lamp, an electronic T-8 ballast and a specular fixture reflector. In some cases, the existing fixture can be modified to accept the new tubes, ballast, and reflector. In other cases the age or style of fixture makes replacement of the entire fixture preferable. The T-8 system is more efficient than the standard fluorescent, eliminates 60 Hz hum and flicker, and provides better color rendition.

Assumptions

The general assumptions stated in Section 2.7.1 apply.

- The existing fixtures and their replacements are distributed as follows:

<u>Existing Fixture Description</u>	<u>Fixture Count</u>		<u>Replace or Retrofit</u>	<u>ERO Description</u>
	<u>off-post</u>	<u>on-post</u>		
2 x 4 4F40	300	188	Retrofit	2 tube T-8 system
1 x 4 2F40	0	88	Retrofit	2 tube T-8 system
0.5 x 4 1F40	0	2,369	Retrofit	1 tube T-8 system
0.5 x 4 2F40	1,740	0	Replace	1 tube T-8 system

Cost estimates are based on the following standard costs taken from the PNL *Lighting Matrix* (Dirks et al. 1992):

<u>ERO Item Description</u>	<u>Installation Material and Labor(\$)</u>	<u>Annualized O&M Cost (\$/yr)</u>
Retrofit w/2 tube T-8 system	155	2.85
Retrofit w/1 tube T-8 system	47	0.78
Replace w/1 tube T-8 system	120	0.30

Results

The quantitative result of this lighting ERO assessment appears in Table 2.12. The table contains specific energy, and cost data for each fluorescent fixture type and electric service area considered in the ERO.

Budget Implications. The total first cost of implementing the ERO in off-post housing is estimated to be \$111,066. The total first cost for on-post housing is \$70,841. These numbers includes the installation and/or replacement of all necessary equipment and materials and associated labor.

Energy, Demand, and Cost Saving. The electric energy savings associated with the off-post implementation of this ERO are estimated to be 226,500 kWh per year at a cost savings of \$20,385 per year. Demand savings are estimated to be 698 kW per year with a cost savings of \$3,846 per year.

The electric energy savings associated with the on-post implementation of this ERO are estimated to be 120,413 kWh per year at a cost savings of \$6,082 per year. Demand savings are estimated to be 372 kW per year with a cost savings of \$2,051 per year. These estimates are based on 100% implementation of the ERO for a typical operating year.

Operations and Maintenance Impacts. Maintenance cost savings for this ERO are estimated to be \$2,127 per year for off-post housing and \$1,712 per year for on-post housing.

Environmental Issues. The disposal of PCB bearing ballasts may have to be addressed as it is not known how many, if any, PCB-type ballasts exist at Fort Drum. If virtually all fluorescent ballasts are targeted for replacement as recommended in this ERO, the beneficial side effect will be the proper disposal of all offending ballasts. Disposal costs should be as low as they will ever be due to economies of scale that result from disposing of all of the ballasts at once.

2.7.11 Upgrade Incandescent with Compact Fluorescent in Family Housing

Description

This ERO consists of retrofitting or replacing most of the interior incandescent fixtures in on-post and off-post family housing with compact fluorescent fixtures. Compact fluorescent systems offer similar light quality at substantial energy savings. Wherever possible, the existing fixture is considered for retrofit to use the compact fluorescent lamps. Due to the different size of the compact fluorescent lamps, some of the fixtures will require replacement, as the new lamp will not fit in the existing fixture. A variety of compact fluorescent systems exist on the market today. Use of a "hard-wired" ballast fixture or retrofit kit provides a permanent fluorescent ballast socket that accepts only compact fluorescent lamps. This will ensure the continued use (and savings) of compact fluorescent technology at lamp replacement.

Assumptions

In addition to the general assumptions stated at the beginning of Section 2.6, the following technical assumptions apply:

- The existing lighting stock consists primarily of surface-mounted ceiling fixtures. The direct compact fluorescent replacements are single or dual lamp kits that use 9- or 13-watt lamps. The QUAD-13 is a single lamp unit that uses a shorter than standard lamp. The quantities of existing fixtures and the type of compact fluorescent kit that will be used to convert each existing fixture are enumerated below:

<u>Existing Fixture Description</u>	<u>Fixture Count</u>		<u>Replace or Retrofit</u>	<u>ERO Description</u>
	<u>off-post</u>	<u>on-post</u>		
INC 2 x 40W	0	1,996	Retrofit	1 x PL-13
INC 3 x 40W	654	0	Retrofit	2 x PL-9
INC 4 x 40W	195	0	Retrofit	2 x PL-9
INC 6-W bare lamp	1,217	0	Replace	1 x PL-11
INC 60-W ceiling	1,095	0	Replace	1 x PL-11
INC 60-W ceiling	1,500	5,448	Retrofit	1 x PL-11
INC 2 x 60-W ceiling	6,807	9,686	Retrofit	2 x PL-11
INC 60-W wall	0	1,996	Retrofit	1 x PL-9
INC 100-W ceiling	2,934	0	Retrofit	2 x PL-9
INC 150-W ceiling	0	464	Retrofit	2 x PL-13

Cost estimates are based on the following standard costs taken from the PNL *Lighting Matrix* (Dirks et al. 1992):

<u>ERO Item Description</u>	<u>Installation Material and Labor(\$)</u>	<u>Annualized O&M Cost (\$/yr)</u>
Retrofit with 1 x PL-11	21	1.5
Retrofit with 2 x PL-9	57	1.6
Replace with PL-11	42	3.1
Retrofit with PL-13	23	3.3
Retrofit with 2 x PL-13	34	6.2
Retrofit with PL-9	20	1.5
Retrofit with 2 x PL-11	33	3.6

Results

The quantitative results of this lighting ERO assessment appear in Table 2.12. The table contains specific energy and cost data for the four-foot incandescent fixtures found in on- and off-post housing.

Budget Implications. The total first cost of implementing the ERO in off-post housing is estimated to be \$513,961. The total first cost for

on-post housing is \$451,407. These numbers includes the installation and/or replacement of all necessary equipment and materials and associated labor.

Energy, Demand, and Cost Saving. The electric energy savings associated with the off-post implementation of this ERO are estimated to be 1,998,179 kWh per year at a cost savings of \$164,773 per year.

The electric energy savings associated with the on-post implementation of this ERO are estimated to be 1,852,142 kWh per year at a cost savings of \$96,561 per year. Demand savings are estimated to be 5,719 kW per year with a cost savings of \$31,512 per year.

These estimates are based on 100% implementation of the ERO for a typical operating year.

Operations and Maintenance Impacts. Maintenance cost savings for this ERO are estimated to be \$59,242 per year for off-post housing and \$56,230 per year for on-post housing, based on lamp replacement by housing maintenance workers rather than occupants.

TABLE 2.8. Lighting EROs for Barracks and New Post Assembly Building Types

Existing lighting operating parameters

Fixture Code	Existing Equipment			Energy Consumption (kWh)			Sum of 12 Monthly Coincident Demands (kW-mo)		
	Fixture Type	Watts Each	No. of Units	On-Peak	Mid-Peak	Off-Peak	On-Peak	Mid-Peak	Off-Peak
27	INC 75 CEIL	75	2,667	142,638	NA	174,952	960	NA	NA
26	INC 2X75	150	7,443	796,140	NA	976,503	5,359	NA	NA
23	INC 2X80 CEIL	120	3,574	305,834	NA	375,120	2,059	NA	NA
33	INC 150 CEIL	150	76	8,129	NA	9,971	55	NA	NA
31	INC 100 CEIL	100	148	10,554	NA	12,945	71	NA	NA
1	FL 2X4 4-40 STD	196	17	2,376	NA	2,914	16	NA	NA
5	FL 2X4 4-34 STD	156	7,881	887,951	NA	1,089,112	5,977	NA	NA
2	FL 2X4 3-40 STD	147	106	11,112	NA	13,629	75	NA	NA
3	FL 2X4 2-40 STD	96	68	4,752	NA	5,829	32	NA	NA
7	FL 2X4 2-34 STD	79	13,674	770,323	NA	944,837	5,185	NA	NA
10	FL 1X4 2-40 STD	96	405	28,303	NA	34,715	191	NA	NA
12	FL 1X4 2-34 STD	79	1,952	109,966	NA	134,878	740	NA	NA
11	FL 1X4 1-40 STD	49	59	2,062	NA	2,529	14	NA	NA
50	FL .5X4 1-34 STD	48	2,846	97,415	NA	119,484	656	NA	NA
47	EXIT 2xPL9	26	500	46,358	NA	67,522	156	NA	NA
46	EXIT 2X20	40	1,608	229,365	NA	334,076	772	NA	NA

Efficient lighting operating parameters

Fixture Code	Energy Resource Opportunity			Energy Consumption			Sum of 12 Monthly		
	New Fixture and/or Control	Watts Each	No. of Units	(kWh)			Coincident Demands (kW-mo)		
				On-Peak	Mid-Peak	Off-Peak	On-Peak	Mid-Peak	Off-Peak
Fixture Upgrade Only:									
27	CFL 2-9 + BLST	26	2,667	49,448	NA	60,650	333	NA	NA
26	CFL 2-13 + BLST	36	7,443	191,074	NA	234,361	1,286	NA	NA
23	CFL 2-11 CEIL	30	3,574	76,459	NA	93,780	515	NA	NA
33	CFL 2-13 + BLST	36	76	1,951	NA	2,393	13	NA	NA
31	CFL 2-9 + BLST	26	148	2,744	NA	3,366	18	NA	NA
1a	FL 2X4 2-40 STD REF	98	17	1,188	NA	1,457	8	NA	NA
1b	FL 2X4 2-T8 ELC REF	65	17	788	NA	966	5	NA	NA
5a	FL 2X4 2-34 STD REF	79	7,881	443,975	NA	544,556	2,988	NA	NA
5b	FL 2X4 2-T8 ELC REF	65	7,881	365,296	NA	448,053	2,459	NA	NA
2	FL 2X4 2-40 ELC REF	74	106	5,594	NA	6,861	38	NA	NA
3	FL 2X4 2-T8 ELC	65	68	3,152	NA	3,866	21	NA	NA
7	FL 2X4 2-T8 ELC	65	13,674	633,810	NA	777,398	4,266	NA	NA
10	FL 1X4 1-40 ELC REF	35	405	10,108	NA	12,398	68	NA	NA
12	FL 1X4 1-34 ELC REF	34	1,952	47,327	NA	58,049	319	NA	NA
11	FL 1X4 1-T8 ELC	29	59	1,220	NA	1,497	8	NA	NA
50	FL .5X4 1-T8 ELC	29	2,846	58,855	NA	72,188	396	NA	NA
47	LED	5	500	8,915	NA	12,985	30	NA	NA
46	LED	5	1,608	28,671	NA	41,760	96	NA	NA
Fixture and Occupancy Sensor:									
2	FL 2X4 2-40 ELC REF	74	81	4,274	NA	5,243	29	NA	NA
2	FL 2X4 2-40 ELC REF + SENS	74	25	1,093	NA	1,358	7	NA	NA
7	FL 2X4 2-T8 ELC	65	12,120	561,780	NA	689,049	3,781	NA	NA
7	FL 2X4 2-T8 ELC + SENS	65	1,554	59,683	NA	74,150	388	NA	NA
12	FL 1X4 1-34 ELC REF	34	1,330	32,246	NA	39,552	217	NA	NA
12	FL 1X4 1-34 ELC REF + SENS	34	622	12,496	NA	15,525	81	NA	NA
Occupancy Sensor Only:									
2	FL 2X4 2-40 ELC REF	74	81	4,274	NA	5,243	29	NA	NA
2	ORIGINAL FIXTURE + SENSOR	147	25	2,171	NA	2,698	14	NA	NA
7	FL 2X4 2-T8 ELC	65	12,120	561,780	NA	689,049	3,781	NA	NA
7	ORIGINAL FIXTURE + SENSOR	79	1,554	72,538	NA	90,121	471	NA	NA
12	FL 1X4 1-34 ELC REF	34	1,330	32,246	NA	39,552	217	NA	NA
12	ORIGINAL FIXTURE + SENSOR	79	622	29,034	NA	36,072	189	NA	NA

TABLE 2.8. (contd)

Efficient lighting ERO economics

Fixture Code	Non-Energy Costs				First Year Energy & Demand Savings					Life Cycle Cost			
	First Cost (\$)	Exist. O&M, \$/yr	Retrofit O&M, \$/yr	Fixture Life, yr	Energy (kWh)	Demand (kW-mo)	Energy (1992 \$)	Demand (1992 \$)	Total (1992 \$)	No Utility Rebate NPV (\$)	Value Index	50% Utility Rebate NPV (\$)	Value Index
Fixture Upgrade Only:													
27	156,926	14,455	9,655	NA	207,492	627	10,469	3,456	13,925	109,688	0.70	188,152	2.40
26	511,036	80,682	46,444	NA	1,347,209	4,073	67,972	22,441	90,413	1,265,079	2.48	1,520,597	5.95
23	234,419	29,021	13,331	NA	510,716	1,544	25,767	8,507	34,275	478,675	2.04	585,866	5.08
33	5,218	501	474	NA	13,756	42	694	229	923	8,177	1.57	10,786	4.13
31	8,708	802	536	NA	17,369	53	877	290	1,167	11,641	1.34	15,965	3.67
1a	886	34	16	NA	2,645	8	133	44	178	1,882	2.12	NA [a]	NA
1b	871	34	7	NA	3,536	11	178	59	237	NA	NA	2,876	3.30
5a	410,600	17,338	7,881	NA	988,532	2,988	49,875	16,466	66,341	662,733	1.61	NA [a]	NA
5b	403,665	17,338	3,152	NA	1,163,714	3,518	58,714	19,385	78,098	NA	NA	904,681	2.24
2	7,155	173	173	NA	12,286	37	620	205	825	0	[b]	6,545	0.91
3	1,783	80	80	NA	3,563	11	180	59	239	0	[b]	2,354	1.32
7	358,532	17,229	17,229	NA	303,953	919	15,335	5,063	20,399	0	[b]	101,410	0.28
10	24,300	474	474	NA	40,511	122	2,044	675	2,719	0	[b]	20,061	0.83
12	118,096	2,460	2,460	NA	139,468	422	7,037	2,323	9,360	0	[b]	44,981	0.38
11	1,393	46	46	NA	1,874	6	95	31	126	0	[b]	881	0.63
50	67,194	2,334	2,334	NA	85,856	260	4,332	1,430	5,762	0	[b]	39,869	0.59
47	70,000	8,440	0	NA	91,960	126	4,584	694	5,278	128,126	1.83	163,126	4.66
46	225,120	68,549	0	NA	493,013	675	24,568	3,721	28,289	1,178,960	5.24	1,291,520	11.47
Fixture and Occupancy Sensor:													
2	5,468	41	41	NA	9,388	28	474	156	630	0	[b]	5,001	0.91
2	2,080	132	132	NA	3,384	11	171	58	229	0	[b]	1,667	0.80
7	317,786	15,271	15,271	NA	269,409	814	13,593	4,488	18,080	0	[b]	89,885	0.28
7	49,557	1,958	1,958	NA	61,089	201	3,088	1,110	4,198	0	[b]	32,213	0.65
12	80,465	784	784	NA	95,027	287	4,794	1,583	6,377	0	[b]	30,648	0.38
12	41,152	1,676	1,676	NA	49,999	155	2,524	852	3,376	0	[b]	16,816	0.41
Occupancy Sensor Only:													
2	5,468	132	132	NA	9,388	28	474	156	630	0	[b]	5,001	0.91
2	784	41	29	NA	966	4	49	19	68	347	0.44	739	1.89
7	317,786	15,271	15,271	NA	269,409	814	13,593	4,488	18,080	0	[b]	89,885	0.28
7	17,607	1,958	1,399	NA	32,263	118	1,635	649	2,285	22,065	1.29	31,439	3.57
12	80,465	1,676	1,676	NA	95,027	287	4,794	1,583	6,377	0	[b]	30,648	0.38
12	7,047	784	560	NA	12,913	47	655	260	915	9,060	1.29	12,583	3.57

[a] With 50% utility rebate, this fixture isn't the best retrofit available. The retrofit consumption, savings, and associated economic information for the best choice with rebate are shown independently. In the fixture code column, those fixtures designated with letter 'a' are the best retrofit without rebate. Those fixtures designated with letter 'b' are the best retrofit with rebate.

[b] With no rebate there is no feasible retrofit.

TABLE 2.9. Lighting EROs for Administration, Medical, Shop, and Old Post Assembly and Communication Buildings

Existing lighting operating parameters

Fixture Code	Existing Equipment			Energy Consumption (kWh)			Sum of 12 Monthly Coincident Demands (kW-mo)		
	Fixture Type	Watts Each	No. of Units	On-Peak	Mid-Peak	Off-Peak	On-Peak	Mid-Peak	Off-Peak
52	INC 75 CAN (EXT)	75	408	15,951	NA	118,408	368	NA	NA
28	INC 75 CAN	75	488	54,720	NA	38,843	285	NA	NA
22	INC 60 CEIL	60	82	5,798	NA	3,905	28	NA	NA
36	INC 200 SUSP	200	538	187,123	NA	112,525	810	NA	NA
35	INC 150 SUSP	150	1,119	281,875	NA	178,187	1,281	NA	NA
32	INC 100 SUSP	100	23	3,588	NA	2,414	17	NA	NA
56	HPS 400 (EXT)	485	233	58,339	NA	418,212	1,300	NA	NA
42	HPS 100 WALL (EXT)	130	277	18,725	NA	138,989	432	NA	NA
49	FL 2X4 8-40 STD	294	883	404,714	NA	272,488	1,983	NA	NA
5	FL 2X4 4-34 STD	158	12,035	2,984,447	NA	1,988,979	14,378	NA	NA
8	FL 2X4 3-34 STD	127	7,870	1,558,185	NA	1,048,135	7,558	NA	NA
7	FL 2X4 2-34 STD	79	1,812	223,185	NA	150,258	1,082	NA	NA
18	FL 1X8 2-88 STD	175	821	223,988	NA	150,811	1,088	NA	NA
10	FL 1X4 2-40 STD	98	2,002	305,888	NA	205,941	1,483	NA	NA
12	FL 1X4 2-34 STD	79	1,401	172,548	NA	118,178	837	NA	NA
11	FL 1X4 1-40 STD	49	20	1,528	NA	1,029	7	NA	NA
15	FL 5X4 2-40 STD	98	214	32,885	NA	22,014	159	NA	NA
50	FL 5X4 1-34 STD	48	72	5,388	NA	3,628	28	NA	NA
46	EXT 2X20	40	838	90,719	NA	132,135	305	NA	NA
45	EXT 2X15	30	887	82,752	NA	135,088	312	NA	NA

Efficient lighting operating parameters

Fixture Code	Energy Resource Opportunity			Energy Consumption (kWh)			Sum of 12 Monthly Coincident Demands (kW-mo)		
	New Fixture and/or Control	Watts Each	No. of Units	On-Peak	Mid-Peak	Off-Peak	On-Peak	Mid-Peak	Off-Peak
Fixture Upgrade Only:									
52	CFL 13 + BLST	18	408	3,828	NA	28,417	88	NA	NA
28	CFL 13 + BLST	18	488	13,133	NA	8,842	84	NA	NA
22	CFL 11 + BLST	15	82	1,450	NA	978	7	NA	NA
36	HPS 50 FLD	79	538	88,013	NA	44,447	320	NA	NA
35	HPS 35 FLD	54	1,119	94,203	NA	63,427	457	NA	NA
32	CFL 2-15 CEIL	40	23	1,434	NA	988	7	NA	NA
56	Reduce Operating Hours	485	233	11,288	NA	20,911	280	NA	NA
42	Reduce Operating Hours	130	277	3,745	NA	8,950	88	NA	NA
49	FL 2X4 2-T8 ELC REF	85	883	89,478	NA	90,248	434	NA	NA
5a	FL 2X4 2-34 STD REF	79	12,035	1,482,224	NA	997,989	7,188	NA	NA
5b	FL 2X4 2-T8 ELC REF	85	12,035	1,219,551	NA	821,131	5,914	NA	NA
6a	FL 2X4 2-T8 EEF REF	72	7,870	883,380	NA	594,785	4,284	NA	NA
6b	FL 2X4 2-T8 ELC REF	85	7,870	797,498	NA	538,959	3,887	NA	NA
7	FL 2X4 2-T8 ELC	85	1,812	183,817	NA	123,830	880	NA	NA
18a	FL 1X8 2-88 ELC	134	821	171,510	NA	115,478	832	NA	NA
18b	FL 1X8 2-80 ELC REF	105	821	134,392	NA	90,487	652	NA	NA
10	FL 1X4 1-40 ELC REF	35	2,002	109,238	NA	73,550	530	NA	NA
12a	FL 1X4 2-34 ELC	83	1,401	137,800	NA	92,847	887	NA	NA
12b	FL 1X4 1-34 ELC REF	34	1,401	74,280	NA	50,000	380	NA	NA
11	FL 1X4 1-T8 ELC	29	20	804	NA	809	4	NA	NA
15	FL 5X4 1-40 ELC REF	35	214	11,877	NA	7,982	57	NA	NA
50	FL 5X4 1-T8 ELC	29	72	3,255	NA	2,192	18	NA	NA
48	LED	5	838	11,340	NA	18,517	38	NA	NA
45	LED	5	887	15,459	NA	22,518	52	NA	NA
Fixture and Occupancy Sensor:									
49	FL 2X4 2-T8 ELC REF	85	577	58,470	NA	39,368	284	NA	NA
49	FL 2X4 2-T8 ELC REF + SENS	85	308	24,824	NA	20,079	113	NA	NA
5a	FL 2X4 2-34 STD REF	79	11,887	1,481,533	NA	984,058	7,087	NA	NA
5a	FL 2X4 2-34 STD REF + SENS	79	188	18,431	NA	13,398	75	NA	NA
5b	FL 2X4 2-T8 ELC REF	85	11,887	1,202,527	NA	808,688	5,831	NA	NA
5b	FL 2X4 2-T8 ELC REF + SENS	85	188	13,519	NA	11,024	82	NA	NA
6a	FL 2X4 2-T8 EEF REF	72	1,889	212,034	NA	142,784	1,028	NA	NA
6a	FL 2X4 2-T8 EEF REF + SENS	72	5,981	533,120	NA	434,728	2,442	NA	NA
6b	FL 2X4 2-T8 ELC REF	85	1,889	191,419	NA	128,884	928	NA	NA
6b	FL 2X4 2-T8 ELC REF + SENS	85	5,981	481,289	NA	392,481	2,204	NA	NA
10	FL 1X4 1-40 ELC REF	35	1,498	81,737	NA	55,034	398	NA	NA
10	FL 1X4 1-40 ELC REF + SENS	35	504	21,838	NA	17,808	100	NA	NA
12a	FL 1X4 2-34 ELC	83	1,187	114,818	NA	77,173	558	NA	NA
12a	FL 1X4 2-34 ELC + SENS	83	234	18,251	NA	14,882	84	NA	NA
12b	FL 1X4 1-34 ELC REF	34	1,187	81,857	NA	41,849	300	NA	NA
12b	FL 1X4 1-34 ELC REF + SENS	34	234	9,849	NA	8,032	45	NA	NA
Occupancy Sensor Only:									
49	FL 2X4 2-T8 ELC REF	85	577	58,470	NA	39,368	284	NA	NA
49	ORIGINAL FIXTURE + SENSOR	294	308	111,375	NA	90,819	510	NA	NA
5a	FL 2X4 2-34 STD REF	79	11,887	1,481,533	NA	984,058	7,087	NA	NA
5b	FL 2X4 2-T8 ELC REF	85	11,887	1,202,527	NA	808,688	5,831	NA	NA
5	ORIGINAL FIXTURE + SENSOR	158	188	32,861	NA	26,798	151	NA	NA
6a	FL 2X4 2-T8 EEF REF	72	1,889	212,034	NA	142,784	1,028	NA	NA
6b	FL 2X4 2-T8 ELC REF	85	1,889	191,419	NA	128,884	928	NA	NA
6	ORIGINAL FIXTURE + SENSOR	127	5,981	940,385	NA	788,809	4,307	NA	NA
10	FL 1X4 1-40 ELC REF	35	1,498	81,737	NA	55,034	398	NA	NA
10	ORIGINAL FIXTURE + SENSOR	98	504	81,147	NA	49,882	280	NA	NA
12a	FL 1X4 2-34 ELC	34	1,187	81,857	NA	41,849	300	NA	NA
12b	FL 1X4 1-34 ELC REF	83	1,187	114,818	NA	77,173	558	NA	NA
12	ORIGINAL FIXTURE + SENSOR	79	234	22,888	NA	18,682	105	NA	NA

TABLE 2.9. (contd)

Efficient lighting ERO economics

										Life Cycle Cost			
Fixture Code	Non-Energy Costs				First Year Energy & Demand Savings					No Utility Rebate		50% Utility Rebate	
	First Cost (\$)	Exist. O&M, \$/yr	Retrofit O&M, \$/yr	Fixture Life, yr	Energy (kWh)	Demand (kW-mo)	Energy (1992 \$)	Demand (1992 \$)	Total (1992 \$)	NPV (\$)	Value Index	NPV (\$)	Value Index
Fixture Upgrade Only:													
52	18,757	6,151	3,072	NA	102,111	280	4,654	1,541	6,195	113,689	6.06	123,068	13.12
28	21,482	4,217	1,970	NA	69,588	202	3,684	1,111	4,775	78,678	3.67	89,407	8.33
22	2,584	419	194	NA	7,278	21	383	116	499	7,736	2.99	9,027	6.99
38	59,498	4,749	5,864	NA	189,187	490	8,907	2,702	11,609	87,446	1.47	117,194	3.94
35	121,971	8,717	14,502	NA	280,232	812	14,753	4,475	19,228	63,609	0.52	124,595	2.04
32	1,509	207	261	NA	3,600	10	190	57	247	1,173	0.78	1,927	2.55
56	17,475	2,826	192	NA	442,373	1,040	20,050	5,731	25,781	384,118	21.98	392,855	44.96
42	20,775	3,080	209	NA	147,029	346	6,664	1,905	8,569	141,991	6.83	152,378	14.87
49	90,455	6,570	962	NA	527,487	1,529	27,771	8,423	36,194	500,966	5.54	546,214	12.08
5a	627,024	54,398	28,403	NA	2,480,213	7,188	130,575	39,605	170,180	2,148,489	3.43	NA [a]	NA
5b	616,433	54,398	13,118	NA	2,919,745	8,462	153,715	46,623	200,339	NA	NA	2,807,656	4.55
6a	1,101,800	28,726	8,500	NA	1,129,154	3,272	59,448	18,031	77,477	284,946	0.26	NA [a]	NA
6b	609,925	28,726	8,578	NA	1,272,865	3,689	67,012	20,325	87,338	NA	NA	914,381	1.50
7	95,021	4,784	1,975	NA	66,176	192	3,484	1,057	4,541	NA [b]	NA	57,586	1.21
16a	57,470	3,801	2,562	NA	87,810	254	4,623	1,402	6,025	45,482	0.79	NA [a]	NA
16b	55,573	3,801	2,471	NA	149,919	434	7,893	2,394	10,287	NA	NA	108,654	1.96
10	240,240	4,965	1,001	NA	329,019	954	17,322	5,254	22,576	135,518	0.56	255,638	2.13
12a	58,842	3,699	1,765	NA	58,475	169	3,079	934	4,012	25,976	0.44	NA [a]	NA
12b	84,761	3,699	785	NA	184,462	477	8,658	2,626	11,285	NA	NA	116,753	1.38
11	944	34	12	NA	1,043	3	55	17	72	377	0.40	849	1.80
15	25,680	531	107	NA	35,170	102	1,852	562	2,413	14,486	0.56	27,326	2.13
50	3,400	127	45	NA	3,569	10	188	57	245	1,260	0.37	2,960	1.74
46	89,040	27,113	0	NA	194,998	267	9,717	1,472	11,189	466,305	5.24	510,825	11.47
45	121,380	36,960	0	NA	189,873	260	9,462	1,433	10,895	574,358	4.73	635,048	10.46
Fixture and Occupancy Sensor:													
49	59,108	4,293	629	NA	344,689	999	18,147	5,504	23,651	327,372	5.54	356,926	12.08
49	36,760	2,277	230	NA	189,982	567	10,033	3,126	13,159	176,359	4.80	194,737	10.59
5a	618,271	53,639	28,006	NA	2,445,591	7,087	128,753	39,052	167,804	2,118,498	3.43	NA [a]	NA
5a	11,609	759	318	NA	39,415	125	2,096	691	2,787	33,456	2.88	NA [a]	NA
5b	607,828	53,639	12,935	NA	2,878,987	8,343	151,570	45,972	197,542	NA	NA	2,768,463	4.55
5b	10,003	759	126	NA	44,701	139	2,370	765	3,135	NA	NA	38,877	3.87
6a	264,460	6,895	2,040	NA	271,026	785	14,269	4,328	18,596	68,395	0.26	NA [a]	NA
6a	912,461	21,831	4,486	NA	1,013,650	3,301	54,034	18,187	72,222	340,122	0.37	NA [a]	NA
6b	146,398	6,895	2,059	NA	305,520	885	16,085	4,879	20,963	NA	NA	219,475	1.50
6b	501,088	21,831	4,486	NA	1,107,746	3,538	58,923	19,495	78,419	NA	NA	838,786	1.67
10	179,760	3,715	749	NA	246,189	713	12,961	3,931	16,892	101,401	0.56	191,281	2.13
10	76,018	1,250	141	NA	89,200	273	4,724	1,506	6,230	26,755	0.35	84,761	1.70
12a	49,014	3,081	1,470	NA	48,709	141	2,564	778	3,342	21,638	0.44	NA [a]	NA
12a	13,801	618	218	NA	15,091	56	817	309	1,127	7,422	0.54	NA [a]	NA
12b	70,604	3,081	654	NA	136,993	397	7,212	2,188	9,400	NA	NA	97,252	1.38
12b	16,144	618	77	NA	30,342	95	1,610	521	2,131	NA	NA	21,341	1.32
Occupancy Sensor Only:													
49	59,108	4,293	629	NA	344,689	999	18,147	5,504	23,651	327,372	5.54	356,926	12.08
49	5,413	2,277	1,854	NA	32,490	170	1,850	937	2,787	37,756	6.97	40,462	14.95
5a	618,271	53,639	28,006	NA	2,445,591	7,087	128,753	39,052	167,804	2,118,498	3.43	NA [a]	NA
5b	607,828	53,639	12,935	NA	2,878,987	8,343	151,570	45,972	197,542	NA	NA	2,768,463	4.55
5	2,656	759	623	NA	9,586	50	546	276	822	10,049	3.52	11,477	8.04
6a	264,460	6,895	2,040	NA	271,026	785	14,269	4,328	18,596	68,395	0.26	NA [a]	NA
6b	146,398	6,895	2,059	NA	305,520	885	16,085	4,879	20,963	NA	NA	219,475	1.50
6	75,121	21,831	17,883	NA	274,323	1,436	15,622	7,910	23,532	294,972	3.93	323,532	8.85
10	179,760	3,715	749	NA	246,189	713	12,961	3,931	16,892	101,401	0.56	191,281	2.13
10	15,538	1,250	1,018	NA	17,838	93	1,016	514	1,530	8,162	0.53	15,932	2.05
12a	49,014	3,081	1,470	NA	136,993	397	7,212	2,188	9,400	21,638	0.44	NA [a]	NA
12b	70,604	3,081	654	NA	48,709	141	2,564	778	3,342	NA	NA	97,252	1.38
12	3,973	618	505	NA	6,676	35	380	193	573	5,272	1.33	7,259	3.65

[a] With 50% utility rebate, this fixture isn't the best retrofit available. The retrofit consumption, savings, and associated economic information for the best choice with rebate are shown independently. In the fixture code column, those fixtures designated with letter 'a' are the best retrofit without rebate. Those fixtures designated with letter 'b' are the best retrofit with rebate.

[b] With no rebate there is no feasible retrofit.

**TABLE 2.10. Lighting for EROs for Retail, Commissary,
and Recreation Buildings**

Existing lighting operating parameters

Fixture Code	Existing Equipment			Energy Consumption (kWh)			Sum of 12 Monthly Coincident Demands (kW-mo)		
	Fixture Type	Watts Each	No. of Units	On-Peak	Mid-Peak	Off-Peak	On-Peak	Mid-Peak	Off-Peak
39	MERC 100	130	130	53,636	NA	30,626	180	NA	NA
51	INC 75 CEIL (EXT)	75	101	3,939	NA	29,240	81	NA	NA
22	INC 60 CEIL	60	910	173,286	NA	98,944	583	NA	NA
1	FL 2X4 4-40 STD	196	890	553,627	NA	316,113	1,863	NA	NA
11	FL 1X4 1-40 STD	49	2,045	318,025	NA	181,587	1,070	NA	NA
14	FL .5X4 1-40 STD	49	1,334	207,455	NA	118,454	698	NA	NA
45	EXIT 2X15	30	51	5,456	NA	7,947	18	NA	NA

Efficient lighting operating parameters

Fixture Code	Energy Resource Opportunity			Energy Consumption (kWh)			Sum of 12 Monthly Coincident Demands (kW-mo)		
	New Fixture and/or Control	Watts Each	No. of Units	On-Peak	Mid-Peak	Off-Peak	On-Peak	Mid-Peak	Off-Peak
Fixture Upgrade Only:									
39	HPS 50 PEND	79	130	32,594	NA	18,611	110	NA	NA
51	CFL 2-9 + BLST	26	101	1,366	NA	10,136	28	NA	NA
22	CFL 11 + BLST	15	910	43,322	NA	24,736	146	NA	NA
1	FL 2X4 2-T8 ELC REF	65	890	183,601	NA	104,833	618	NA	NA
11	FL 1X4 1-T8 ELC	29	2,045	188,219	NA	107,470	633	NA	NA
14	FL .5X4 1-T8 ELC	29	1,334	122,779	NA	70,105	413	NA	NA
45	LED	5	51	909	NA	1,324	3	NA	NA

Efficient lighting ERO economics

Fixture Code	Non-Energy Costs				First Year Energy & Demand Savings					Life Cycle Cost			
	First Cost \$	Exist. O&M \$	Retrofit O&M \$	Fixture Life, yr.	Energy (kWh)	Demand (kW-mo)	Energy (1992 \$)	Demand (1992 \$)	Total (1992 \$)	No Utility Rebate NPV \$	Value Index	50% Utility Rebate NPV \$	Value Index
Fixture Upgrade Only:													
39	19,890	1,229	1,219	NA	33,057	71	1,759	390	2,149	10,492	0.53	20,437	2.05
51	2,971	1,519	1,225	NA	21,677	53	988	291	1,279	16,892	2.84	19,863	6.68
22	18,964	11,657	5,961	NA	204,173	437	10,866	2,410	13,276	232,514	6.13	251,469	13.26
1	45,586	7,885	3,516	NA	581,306	1,245	30,938	6,861	37,799	504,882	5.54	550,468	12.08
11	48,282	7,444	5,828	NA	203,923	437	10,853	2,407	13,260	113,744	1.18	162,026	3.36
14	31,496	4,856	3,802	NA	133,024	285	7,080	1,570	8,650	74,198	1.18	105,694	3.36
45	7,140	2,174	0	NA	11,169	15	557	84	641	33,786	4.73	37,356	10.46

TABLE 2.11. Lighting EROs for Clubs and Mess Halls

Existing lighting operating parameters

Fixture Code	Existing Equipment			Energy Consumption (kWh)			Sum of 12 Monthly Coincident Demands (kW-mo)		
	Fixture Type	Watts Each	No. of Units	On-Peak	Mid-Peak	Off-Peak	On-Peak	Mid-Peak	Off-Peak
23	INC 2X60 CEIL	120	86	21,898	NA	20,368	90	NA	NA
5	FL 2X4 4-34 STD	158	134	65,039	NA	60,490	269	NA	NA
6	FL 2X4 3-34 STD	127	735	203,455	NA	189,223	840	NA	NA
7	FL 2X4 2-34 STD	79	173	28,999	NA	26,971	120	NA	NA
8	FL 1X4 2-34 STD WP	79	1,532	256,804	NA	238,841	1,060	NA	NA
46	EXIT 2X20	40	129	18,401	NA	26,801	62	NA	NA

Efficient lighting operating parameters

Fixture Code	Energy Resource Opportunity			Energy Consumption (kWh)			Sum of 12 Monthly Coincident Demands (kW-mo)		
	New Fixture and/or Control	Watts Each	No. of Units	On-Peak	Mid-Peak	Off-Peak	On-Peak	Mid-Peak	Off-Peak
Fixture Upgrade Only:									
23	CFL 2-11 CEIL	30	86	5,474	NA	5,091	23	NA	NA
5	FL 2X4 2-T8 ELC REF	65	194	26,757	NA	24,885	110	NA	NA
6	FL 2X4 2-T8 ELC REF	65	755	104,130	NA	96,847	430	NA	NA
7	FL 2X4 2-T8 ELC	65	173	23,860	NA	22,191	99	NA	NA
8	FL 1X4 1-34 ELC REF	34	1,532	110,523	NA	102,793	456	NA	NA
46	LED	5	129	2,300	NA	3,350	8	NA	NA
Fixture and Occupancy Sensor:									
5	FL 2X4 2-T8 ELC REF + SENS	65	194	22,888	NA	21,698	110	NA	NA
6	FL 2X4 2-T8 ELC REF	65	173	23,860	NA	22,191	99	NA	NA
6	FL 2X4 2-T8 ELC REF + SENS	65	582	68,663	NA	65,095	331	NA	NA
8	FL 1X4 1-34 ELC REF	34	367	26,477	NA	24,625	109	NA	NA
8	FL 1X4 1-34 ELC REF + SENS	34	1,165	71,894	NA	68,157	347	NA	NA
Occupancy Sensor Only:									
5	ORIGINAL FIXTURE + SENSOR	158	194	55,635	NA	52,743	201	NA	NA
6	FL 2X4 2-T8 ELC REF	65	173	23,860	NA	22,191	99	NA	NA
6	ORIGINAL FIXTURE + SENSOR	127	582	134,157	NA	127,185	486	NA	NA
8	FL 1X4 1-34 ELC REF	34	367	26,477	NA	24,625	109	NA	NA
8	ORIGINAL FIXTURE + SENSOR	79	1,165	167,047	NA	158,366	605	NA	NA

Efficient lighting ERO economics

										Life Cycle Cost			
Fixture Code	Non-Energy Costs				First Year Energy & Demand Savings					No Utility Rebate		50% Utility Rebate	
	First Cost \$	Exist. O&M, \$/yr	Retrofit O&M, \$/yr	Fixture Life, yr	Energy (kWh)	Demand (kW-mo)	Energy (1992 \$)	Demand (1992 \$)	Total (1992 \$)	NPV \$	Value Index	NPV \$	Value Index
Fixture Upgrade Only:													
23	2,821	1,809	966	NA	31,698	68	1,632	374	2,005	34,526	6.12	37,346	13.24
5	9,937	1,482	553	NA	73,887	158	3,803	871	4,674	59,589	3.00	69,526	7.00
6	58,513	4,666	2,152	NA	191,701	410	9,867	2,259	12,127	90,656	0.77	149,169	2.55
7	4,536	777	493	NA	9,919	21	511	117	627	3,929	0.43	8,465	1.87
8	92,686	6,879	2,880	NA	282,330	604	14,532	3,328	17,860	124,834	0.67	217,520	2.35
46	18,060	5,499	0	NA	39,551	54	1,971	299	2,269	94,580	5.24	103,610	11.47
Fixture and Occupancy Sensor:													
5	11,933	1,482	421	NA	80,943	158	4,170	871	5,040	63,822	2.67	75,753	6.35
6	13,408	1,069	493	NA	43,926	94	2,261	518	2,779	20,773	0.77	34,180	2.55
6	49,098	3,597	1,263	NA	168,942	316	8,705	1,742	10,447	86,676	0.88	135,768	2.77
8	22,204	1,648	690	NA	67,634	145	3,481	797	4,278	29,905	0.67	52,108	2.35
8	74,478	5,231	1,596	NA	236,860	459	12,202	2,530	14,732	115,441	0.78	189,908	2.55
Occupancy Sensor Only:													
5	1,995	1,482	1,251	NA	17,151	67	890	370	1,260	14,931	3.74	16,927	8.46
6	13,408	1,069	493	NA	43,926	94	2,261	518	2,779	20,773	0.77	34,180	2.55
6	3,990	3,597	3,038	NA	41,358	162	2,147	892	3,039	37,679	4.72	41,669	10.44
8	22,204	1,648	690	NA	67,634	145	3,481	797	4,278	29,905	0.67	52,108	2.35
8	7,980	5,231	4,415	NA	51,498	202	2,674	1,111	3,784	50,630	6.34	54,621	13.69

TABLE 2.12. Lighting EROs for Off-Post and On-Post Housing

Existing lighting operating parameters

Fixture Code	Existing Equipment		No. of Units	Energy Consumption (kWh)			Sum of 12 Monthly Coincident Demands (kW-mo)		
	Fixture Type	Watts Each		On-Peak	Mid-Peak	Off-Peak	On-Peak	Mid-Peak	Off-Peak
23	INC 2X60 CEIL	120	6,807	NA	1,296,938	NA	NA	NA	NA
19	INC 3X40	120	654	NA	124,607	NA	NA	NA	NA
31	INC 100 CEIL	100	2,934	NA	465,848	NA	NA	NA	NA
15	FL .5X4 2-40 STD	98	1,740	NA	270,743	NA	NA	NA	NA
1	FL 2X4 4-40 STD	198	300	NA	93,360	NA	NA	NA	NA
20	INC 4X40	160	195	NA	49,538	NA	NA	NA	NA
22	INC 60 CEIL	60	1,095	NA	104,315	NA	NA	NA	NA
22	INC 60 CEIL	60	1,500	NA	142,898	NA	NA	NA	NA
21	INC 60 BARE	60	1,217	NA	115,938	NA	NA	NA	NA
22	INC 60 CEIL	60	5,448	233,098	NA	285,906	1,569	NA	NA
10	FL 1X4 2-40 STD	98	88	6,150	NA	7,543	41	NA	NA
14	FL .5X4 1-40 STD	49	2,369	82,777	NA	101,530	557	NA	NA
24	INC 60 WALL	60	1,996	85,401	NA	104,748	575	NA	NA
18	INC 2X40	60	1,996	113,868	NA	139,664	766	NA	NA
23	INC 2X60 CEIL	120	9,686	828,850	NA	1,018,623	5,579	NA	NA
1	FL 2X4 4-40 STD	198	188	26,276	NA	32,229	177	NA	NA
33	INC 150 CEIL	150	464	49,632	NA	60,876	334	NA	NA

Efficient lighting operating parameters

Efficient lighting operating parameters				Energy Consumption			Sum of 12 Monthly		
Fixture Code	Energy Resource Opportunity	Watts Each	No. of Units	(kWh)			Coincident Demands (kW-mo)		
	New Fixture and/or Control			On-Peak	Mid-Peak	Off-Peak	On-Peak	Mid-Peak	Off-Peak
Fixture Upgrade Only:									
23	CFL 2-11 CEIL	30	6,807	NA	324,234	NA	NA	NA	NA
19	CFL 2-9 + BLST	26	654	NA	28,998	NA	NA	NA	NA
31	CFL 2-9 + BLST	26	2,934	NA	121,120	NA	NA	NA	NA
15a	FL .5X4 2-T8 ELC	65	1,740	NA	179,575	NA	NA	NA	NA
15b	FL .5X4 1-T8 EEF REF	37	1,740	NA	102,219	NA	NA	NA	NA
1	FL 2X4 2-T8 ELC REF	65	300	NA	30,961	NA	NA	NA	NA
20	CFL 2-9 + BLST	26	195	NA	8,050	NA	NA	NA	NA
22	CFL 11 CEIL FXT	15	1,085	NA	26,079	NA	NA	NA	NA
22	CFL 11 + BLST	15	1,500	NA	35,724	NA	NA	NA	NA
21	CFL 11 CEIL FXT	15	1,217	NA	28,984	NA	NA	NA	NA
22	CFL 11 + BLST	15	5,448	58,275	NA	71,476	392	NA	NA
10	FL 1X4 1-40 ELC REF	35	88	2,196	NA	2,694	15	NA	NA
14	FL .5X4 1-T8 ELC	29	2,369	48,991	NA	60,089	330	NA	NA
24	CFL 9 + BLST	13	1,996	18,504	NA	22,695	125	NA	NA
18	CFL 13 + BLST	18	1,996	25,620	NA	31,424	172	NA	NA
23	CFL 2-11 CEIL	30	9,686	207,213	NA	254,156	1,395	NA	NA
1a	FL 2X4 2-40 STD REF	98	188	13,138	NA	16,115	88	NA	NA
1b	FL 2X4 2-T8 ELC REF	65	188	8,714	NA	10,688	59	NA	NA
33	CFL 2-13 + BLST	36	464	11,912	NA	14,610	80	NA	NA

Efficient lighting ERO economics

Efficient lighting ERO economics										Life Cycle Cost			
Non-Energy Costs					First Year Energy & Demand Savings					No Utility Rebate		50% Utility Rebate	
Fixture Code	First Cost (\$)	Exist. O&M, \$/yr	Retrofit O&M, \$/yr	Fixture Life, yr	Energy (kWh)	Demand (kW-mo)	Energy (1992 \$)	Demand (1992 \$)	Total (1992 \$)	NPV \$	Value Index	NPV \$	Value Index
Fixture Upgrade Only:													
23	223,270	54,252	24,777	NA	972,703	NA	87,543	NA	87,543	1,218,459	2.73	1,441,660	6.46
19	19,241	5,297	2,309	NA	97,609	NA	8,785	NA	8,785	129,048	3.35	148,288	7.71
31	86,318	15,638	10,357	NA	344,726	NA	31,025	NA	31,025	341,617	1.98	427,935	4.96
15a	91,246	1,984	661	NA	91,169	NA	8,205	NA	8,205	43,667	0.48	NA	[a] NA
15b	95,700	1,984	331	NA	168,524	NA	15,167	NA	15,167	NA	NA	142,068	1.48
1	15,366	588	114	NA	62,399	NA	5,616	NA	5,616	55,280	1.80	70,646	4.60
20	5,737	2,106	688	NA	41,488	NA	3,734	NA	3,734	61,895	5.39	67,632	11.79
22	113,536	21,738	8,226	NA	78,236	NA	7,041	NA	7,041	74,464	1.20	105,595	3.39
22	31,260	5,985	2,265	NA	107,173	NA	9,646	NA	9,646	127,873	2.05	159,118	5.09
21	34,599	4,856	2,008	NA	86,953	NA	7,826	NA	7,826	82,761	1.20	117,360	3.39
22	31,131	4,369	1,807	NA	389,253	1,177	19,639	6,484	26,123	339,270	1.49	452,751	3.99
10	5,280	100	12	NA	8,802	27	444	147	591	[b]	NA	4,333	0.82
14	55,932	1,777	450	NA	75,228	227	3,796	1,253	5,049	[b]	NA	34,657	0.62
24	40,878	7,964	2,954	NA	148,950	450	7,515	2,481	9,996	132,607	1.62	173,465	4.24
18	45,768	10,778	4,232	NA	196,487	594	9,913	3,273	13,186	190,304	2.08	236,072	5.16
23	317,701	77,197	35,257	NA	1,384,105	4,184	69,833	23,056	92,889	1,288,740	2.03	1,606,344	5.06
1a	9,795	368	171	NA	29,253	88	1,476	487	1,963	20,757	2.12	NA	[a] NA
1b	9,629	368	71	NA	39,103	118	1,973	651	2,624	NA	NA	31,697	3.29
33	15,929	3,002	2,830	NA	83,986	254	4,237	1,399	5,636	50,060	1.57	65,989	4.14

[a] With 50% utility rebate, this fixture isn't the best retrofit available. The retrofit consumption, savings, and associated economic information for the best choice are shown independently. In the fixture code column, those fixtures designated with letter 'a' are the best retrofit without rebate. Those fixtures designated with letter 'b' are the best retrofit with rebate.

[b] With no rebate there is no feasible retrofit.

TABLE 2.13. Occupancy Sensors for Small Offices, Dayrooms and Restrooms

Existing lighting operating parameters

Fixture Code	Existing Equipment				Energy Consumption (kWh)			Sum of 12 Monthly Coincident Demands (kW-mo)		
	Fixture Type	No. Controlled	Watts Each	No. of Units	On-Peak	Mid-Peak	Off-Peak	On-Peak	Mid-Peak	Off-Peak
5a	FL 2X4 4-34 STD	2	158	326	243,787	NA	19,264	618	NA	NA
5b	FL 2X4 4-34 STD	2	158	326	183,956	NA	26,764	618	NA	NA
5c	FL 2X4 4-34 STD	2	158	3,740	1,382,753	NA	NA	7,091	NA	NA
5d	FL 2X4 4-34 STD	2	158	329	121,638	NA	37,323	624	NA	NA
5e	FL 2X4 4-34 STD	2	158	60	20,145	NA	NA	114	NA	NA
5f	FL 2X4 4-34 STD	3	158	168	59,724	NA	NA	319	NA	NA
6a	FL 2X4 3-34 STD	4	127	268	72,327	NA	NA	408	NA	NA
6b	FL 2X4 3-34 STD	3	127	645	174,069	NA	NA	983	NA	NA
6c	FL 2X4 3-34 STD	2	127	936	252,003	NA	NA	1,426	NA	NA
6d	FL 2X4 3-34 STD	1	127	24	7,132	NA	2,186	37	NA	NA
7a	FL 2X4 2-34 STD	2	79	152	25,517	NA	NA	144	NA	NA
7b	FL 2X4 2-34 STD	2	79	316	58,416	NA	17,924	300	NA	NA
7c	FL 2X4 2-34 STD	1	79	24	4,029	NA	NA	23	NA	NA
23	INC 2X60 CEIL	2	120	16	4,493	NA	1,379	23	NA	NA

Occupancy sensor operating parameters

Fixture Code	Energy Resource Opportunity				Energy Consumption			Sum of 12 Monthly		
	Fixture Type	No. Controlled	Watts Each	No. of Units	(kWh)			Coincident Demands (kW-mo)		
					On-Peak	Mid-Peak	Off-Peak	On-Peak	Mid-Peak	Off-Peak
Occupancy Sensor Only:										
5a	FL 2X4 4-34 STD	2	158	326	179,454	NA	8,035	464	NA	NA
5b	FL 2X4 4-34 STD	2	158	326	130,171	NA	4,821	464	NA	NA
5c	FL 2X4 4-34 STD	2	158	3,740	738,650	NA	NA	5,318	NA	NA
5d	FL 2X4 4-34 STD	2	158	329	64,978	NA	6,498	468	NA	NA
5e	FL 2X4 4-34 STD	2	158	60	9,480	NA	NA	85	NA	NA
5f	FL 2X4 4-34 STD	3	158	168	33,180	NA	NA	239	NA	NA
6a	FL 2X4 3-34 STD	4	127	268	34,036	NA	NA	306	NA	NA
6b	FL 2X4 3-34 STD	3	127	645	81,915	NA	NA	737	NA	NA
6c	FL 2X4 3-34 STD	2	127	936	118,872	NA	NA	1,071	NA	NA
6d	FL 2X4 3-34 STD	1	127	24	3,810	NA	381	27	NA	NA
7a	FL 2X4 2-34 STD	2	79	152	12,008	NA	NA	108	NA	NA
7b	FL 2X4 2-34 STD	2	79	316	31,205	NA	3,121	225	NA	NA
7c	FL 2X4 2-34 STD	1	79	24	1,896	NA	NA	17	NA	NA
23	INC 2X60 CEIL	2	120	16	2,400	NA	240	17	NA	NA
Fixture and Sensor:										
5a	FL 2X4 2-T8 ELC REF	2	65	326	73,826	NA	3,306	191	NA	NA
5b	FL 2X4 2-T8 ELC REF	2	65	326	53,551	NA	1,983	191	NA	NA
5c	FL 2X4 2-T8 ELC REF	2	65	3,740	303,875	NA	NA	2,188	NA	NA
5d	FL 2X4 2-T8 ELC REF	2	65	329	26,731	NA	2,673	192	NA	NA
5e	FL 2X4 2-T8 ELC REF	2	65	60	3,900	NA	NA	35	NA	NA
5f	FL 2X4 2-T8 ELC REF	3	65	168	13,650	NA	NA	98	NA	NA
6a	FL 2X4 2-T8 ELC REF	4	65	268	17,420	NA	NA	157	NA	NA
6b	FL 2X4 2-T8 ELC REF	3	65	645	41,925	NA	NA	377	NA	NA
6c	FL 2X4 2-T8 ELC REF	2	65	936	60,840	NA	NA	548	NA	NA
6d	FL 2X4 2-T8 ELC REF	1	65	24	1,950	NA	195	14	NA	NA
7a	FL 2X4 2-T8 ELC	2	65	152	9,880	NA	NA	89	NA	NA
7b	FL 2X4 2-T8 ELC	2	65	316	25,675	NA	2,568	185	NA	NA
7c	FL 2X4 2-T8 ELC REF	1	65	24	1,560	NA	NA	14	NA	NA
23	CFL 2-11 CEIL	2	30	16	600	NA	60	4	NA	NA

TABLE 2.13. (contd)

Occupancy sensor ERO economics

Occupancy sensor ERO economics										Life Cycle Cost			
Fixture Code	Non-Energy Costs			Fixture Life, yr	First Year Energy & Demand Savings					No Utility Rebate		50% Utility Rebate	
	First Cost (\$)	Exist. O&M, \$/yr	Retrofit O&M, \$/yr		Energy (kWh)	Demand (kW-mo)	Energy (1992 \$)	Demand (1992 \$)	Total (1992 \$)	NPV (\$)	Value Index	NPV (\$)	Value Index
Occupancy Sensor Only:													
5a	11,084	4,352	2,967	NA	75,562	155	4,261	851	5,113	81,223	7.33	86,765	15.66
5b	30,155	3,394	1,995	NA	75,727	155	4,113	851	4,964	60,252	2.00	75,329	5.00
5c	127,160	18,737	7,143	NA	644,103	1,773	37,738	9,768	47,506	711,741	5.60	775,321	12.19
5d	30,433	2,435	760	NA	87,486	156	4,670	859	5,530	71,988	2.37	87,204	5.73
5e	2,040	278	51	NA	10,665	26	625	157	782	12,291	6.02	13,311	13.05
5f	3,808	842	321	NA	26,544	80	1,555	439	1,994	31,905	8.38	33,809	17.76
6a	4,556	1,034	222	NA	38,291	102	2,243	563	2,806	46,863	10.29	49,141	21.57
6b	14,620	2,490	535	NA	92,154	246	5,399	1,354	6,753	109,131	7.46	116,441	15.93
6c	31,824	3,613	777	NA	133,731	357	7,835	1,965	9,800	147,758	4.64	163,670	10.29
6d	4,440	149	45	NA	5,130	9	274	50	324	1,639	0.37	3,859	1.74
7a	5,168	420	87	NA	13,509	36	791	198	990	13,654	2.64	16,238	6.28
7b	29,230	1,406	423	NA	42,014	75	2,243	413	2,656	22,577	0.77	37,192	2.54
7c	1,632	66	14	NA	2,133	6	125	31	156	1,340	0.82	2,156	2.64
23	1,480	256	115	NA	3,231	6	173	32	204	3,476	2.35	4,216	5.70
Fixture and Sensor:													
5a	44,336	4,352	971	NA	185,920	427	10,657	2,355	13,012	188,453	4.25	210,621	9.50
5b	44,336	3,394	385	NA	155,184	427	8,726	2,355	11,081	140,549	3.17	162,717	7.34
5c	508,640	18,737	1,047	NA	1,078,878	4,903	63,211	27,016	90,228	1,021,127	2.01	1,275,447	5.02
5d	44,744	2,435	118	NA	129,557	431	7,079	2,377	9,456	122,354	2.73	144,726	6.47
5e	8,160	278	7	NA	16,245	79	952	433	1,385	15,311	1.88	19,391	4.75
5f	20,944	842	47	NA	46,074	220	2,699	1,214	3,913	45,802	2.19	56,274	5.37
6a	46,096	1,034	32	NA	54,907	252	3,217	1,387	4,604	33,419	0.72	56,467	2.45
6b	114,595	2,490	77	NA	132,144	606	7,742	3,337	11,079	76,775	0.67	134,073	2.34
6c	176,904	3,613	112	NA	191,763	879	11,235	4,843	16,078	100,806	0.57	189,258	2.14
6d	5,352	149	9	NA	7,176	23	391	124	515	3,953	0.74	6,629	2.48
7a	20,672	420	18	NA	15,637	55	916	304	1,220	2,394	0.12	12,730	1.23
7b	42,976	1,406	114	NA	48,097	115	2,591	632	3,223	21,366	0.50	42,854	1.99
7c	4,080	66	3	NA	2,469	9	145	48	193	(438)	-0.11	1,602	0.79
23	1,600	256	186	NA	5,211	19	286	103	389	4,916	3.07	5,716	7.15

2.8 STREETLIGHTING EROs

Streetlighting energy efficiency opportunities involve four measures: 1) delamping, 2) rezoning, 3) combined delamp/rezone, and 4) fixture upgrade. The first three measures aim to correct the over-illuminated roadways on the New Post. The combined delamp/rezoning ERO will save the most energy but have the longest payback. The fixture upgrade ERO pertains to the mercury vapor streetlight fixtures on the Old Post.

There are no EROs that apply to on-post housing area streets, because the existing lighting equipment in these areas is efficient, and reduced illumination in these areas will not be considered.

Some important observations were made during data collection activities that are applicable to the streetlighting issue. While the main entry road appears significantly over-lit, there are areas on the Fort that appear to present a security problem due to inadequate illumination at night. All of the New Post barracks parking lot and exterior wall areas are extremely dark. This is in stark contrast to the over-lit shop exterior areas. For personnel security reasons, it seems that more lighting may be needed here. Many of the streets and lot areas on the Old Post are also very under-lit, again raising the security issue.

2.8.1 Delamp New Post Two- and Four-Lane Streets

Description

The lighting levels can be reduced by 50% on most of the New Post streets with little adverse safety or security impact. This is accomplished by removing or disconnecting the lamp or ballast from every other lamp post.

Two delamping options are analyzed. The first option is to delamp half of the fixtures on four-lane roads that have poles on both sides of the street except at intersections. This option will eliminate 300 lamps. A further delamping option is to delamp half the fixtures on the two-lane roads except at intersections. The second option will eliminate another 250 lamps.

Assumptions

The technical data and assumptions used in the analysis are as follows:

- New Post streetlight hours of operation were calculated based on an on-cycle starting 15 minutes after sunset and ending 15 minutes before sunrise. This is an average schedule--the actual on-times are staggered slightly.
- The streetlighting fixture count is from the construction drawings and schedules, which appear to be complete and accurate. The distribution of light fixtures by circuit and transformer is as tabulated in Volume 2.
- The New Post streetlights are all 250 watt high-pressure sodium (HPS) units distributed by road category approximately as follows:

<u>Road Category</u>	<u>Quantity</u>	<u>Layout</u>	<u>Spacing</u>
4-lane	600 lamps	both sides	230 ft
2-lane	500 lamps	one side	200 ft
Intersections	188 lamps	four corners	NA

- Ballasts dissipate 45 W per lamp.

Cost assumptions are as follows:

- Cost to delamp (remove a lamp) is \$6 per fixture.
- O&M costs include \$8 labor to replace a lamp plus the \$24 cost of a lamp. Lamps will be replaced every 2 years under the current operating schedule and every four years if turned off in low traffic hours (11:30 pm to 5:00 am).

Results

Quantitative results of the ERO analysis are presented in Table 2.14 (p. 2.115). The results are discussed below.

Budget Implications. Streetlight delamping EROs represent a large energy conservation potential for a small investment. The estimated first cost is \$5700.

Energy Demand and Cost Savings. The electric energy savings estimated to result from implementation of this ERO are 680,000 kWh per year at a cost

savings of \$32,000 per year. Demand savings are estimated to be 1950 kW-months per year with a cost savings of \$10,700 per year.

Operations and Maintenance. Maintenance is reduced in direct proportion to the number of fixtures that are delamped. Thus, the first delamping option will reduce maintenance costs of New Post streetlamps by almost 25%, and the second option will reduce maintenance costs by another 20%.

Energy Security. This ERO has little impact on energy security.

Environmental Issues. There are no environmental impacts beyond the generally beneficial effects of reduced energy consumption and demand.

2.8.2 Rezone New Post Streetlights and Reduce Operating Hours

Description

The streetlights can be turned off during low-traffic hours with little adverse safety or security impact if intersection lights are left on. This is accomplished by rewiring the intersection lights to operate on a separate clock schedule so that the fixtures between intersections can be turned off in low-traffic hours. This option will reduce the load by 950, 650 or 400 lamps, depending on which, if any, delamping option is chosen, during off-peak times.

Assumptions

Technical assumptions are as follows:

The delamping parameters and assumptions apply as well as the following:

- 400 feet of 2 x 14 gage wire must be pulled to rewire a two-lane intersection.
- 500 feet of 2 x 14 gage wire must be pulled to rewire a four-lane intersection.
- an extra channel is available on each of the existing time clocks to provide separate schedules for intersection and non-intersection circuits.

Cost estimates are as follows:

- Cost to rewire a two-lane intersection is \$290. Cost to rewire a four-lane intersection is \$464. Cost to rewire the existing timer and add a 5-amp relay in the existing cabinet is \$114 for either type of intersection.

Results

Quantitative results of the ERO analysis are presented in Table 2.14. The results are discussed below.

Budget Implications. The streetlight rezoning ERO represents a large energy conservation potential. The rezoning ERO has significant first costs of about \$23,700 but very little risk; i.e., the projected savings are not predicated on assumed operator or occupant behaviors, weather, or uncertain loads.

Energy Demand and Cost Savings. The electric energy savings estimated to result from implementation of this ERO are 406,000 kWh per year at a cost savings of \$18,000 per year. There are no demand savings, because the new operating schedules reduce the lighting load only after 10 p.m.

Operations and Maintenance. The rezoning measure will, in principle, result in additional maintenance of the additional wiring. However, this will be more than offset by the maintenance savings that result from reduced lamp operation.

Energy Security. This ERO has little impact on energy security.

Environmental Issues. There are no environmental impacts beyond the generally beneficial effects of reduced energy consumption and demand.

2.8.3 Combined Delamp/Rezone of New Post Streetlights

Description

This ERO is a combination of the two previous EROs, streetlight rezoning and delamping.

Assumptions

The data in subsections 2.8.1 and 2.8.2 (Delamp and Rezone EROs) applies.

Results

Quantitative results of the ERO analysis are presented in Table 2.14. The results are discussed below.

Budget Implications. The combined streetlight rezoning and delamping EROs represent a large energy conservation potential. The EROs have significant first costs but very little risk; i.e., the projected savings are not predicated on assumed operator or occupant behavior, weather, or uncertain loads. The first cost is estimated to be \$29,400.

Energy Demand and Cost Savings. The electric energy savings estimated to result from implementation of this ERO are 846,000 kWh per year at a cost savings of \$39,000 per year. Demand savings are estimated to be 1950 kW-months per year with a cost savings of \$10,700 per year.

Operations and Maintenance. The rezoning measure will result in maintenance savings of \$8,500.

Energy Security. This ERO has little impact on energy security.

Environmental Issues. There are no environmental impacts beyond the generally beneficial effects of reduced energy consumption and demand.

2.8.4 Mercury-Vapor to HPS Fixture Upgrade on the Old Post

Description

There are 253 existing streetlight fixtures on the Old Post that can be upgraded from an existing 400-watt mercury-vapor lamp fixture to an HPS lamp fixture. An upgrade to 200-watt HPS fixtures will result in slightly higher light levels. Large areas of the Old Post appear to be under-lit. In general, there is a need for more lights rather than brighter lights. Installation of additional lights was not considered in this analysis; however, an upgrade to 250-watt HPS fixtures that will result in 30% more light was considered. This upgrade may be desirable in some locations.

Assumptions

The performance analysis is based on the following data and technical assumptions specific to this ERO:

- A 200-watt HPS provides 5% more light than a 400-watt mercury vapor fixture

- The existing ballast dissipates 54 watts; the 250-watt HPS ballast dissipates 45 watts; the 200-watt HPS ballast dissipates 40 watts (source: Magnetek Universal Manufacturing).

The economic analysis is based on the following cost data and assumptions:

- The maintenance cost difference between the existing mercury vapor system and the 250-watt HPS system is negligible. The maintenance cost for the 200-watt HPS system is less because the lamp costs 15% less than the 250-watt lamp.
- The implementation costs, based on a Fort Drum DEH Energy Branch analysis (92/02/28) of the 250-watt HPS fixture replacement, are as follows:

	<u>250 W</u>	<u>200 W</u>
Fixture	132	125
Lamp	23	20
Labor	<u>25</u>	<u>25</u>
	\$180	\$170

- The upgraded fixture's service life is 15 years.

Results

Quantitative results of the ERO analysis are presented in Table 2.15 (p. 2.116). The results are discussed below.

Budget Implications. The first cost of the 200-watt version of this ERO is \$54,400.

Energy, Demand, and Cost Savings. The electric energy savings associated with implementation of this ERO is estimated to be 227,000 kWh per year at a cost savings of \$10,600 per year. Demand savings are estimated to be 650 kW-months per year with a cost savings of \$3,600 per year. These savings represents about 25% of the current energy operating costs incurred by the Old Post streetlighting system.

Energy Security. This ERO has no direct impact on energy security.

Operations and Maintenance. There will be no significant additional maintenance requirement.

Environmental Issues. This ERO has no direct environmental impact.

TABLE 2.14. New Post Streetlighting EROs

Existing street lighting parameters/operation

ID	Existing Equipment			No. of Units	Operating Schedule			Coincid. Peak Factor	Energy Consumption (kWh)			Sum of 12 Monthly Coincident demands (kW-mo)		
	Equip Code	Lamp Type	Size (kW)		Hrs on-peak	Hrs mid-peak	Hrs off-peak		on-peak	mid-peak	off-peak	on-peak	mid-peak	off-peak
1	SL-1	High Pres. Sodium	0.295	1,288	844	NA	3,348	1.0	320,859	NA	1,272,113	4,560	NA	NA

Delampd street lighting parameters/operation

ID	Energy Resource Opportunity			No. of Units	Operating Schedule			Coincid. Peak Factor	Energy Consumption (kWh)			Sum of 12 Monthly Coincident demands (kW-mo)		
	Equip Code	ERO Description	Size (kW)		Hrs on-peak	Hrs mid-peak	Hrs off-peak		on-peak	mid-peak	off-peak	on-peak	mid-peak	off-peak
1A	SLD-1	Delamp 4-Lane	0.295	988	844	NA	3,348	1.0	246,125	NA	975,813	3,498	NA	NA
1B	SLD-2	Delamp 2-Lane	0.295	1,038	844	NA	3,348	1.0	258,580	NA	1,025,197	3,675	NA	NA
1C	SLD-3	Delamp Both	0.295	738	844	NA	3,348	1.0	183,846	NA	728,897	2,613	NA	NA

Delampd street lighting ERO economics

ID	Economic Parameters							First Year Energy & Demand Savings					Life Cycle Cost	
	Equip Code	No. of Units	First Cost (\$)	Before O&M \$	After O&M \$	Life Yr	Salvage \$	Energy (kWh)	Demand (kW-mo)	Energy (1992 \$)	Demand (1992 \$)	Total (1992 \$)	NPV \$	Value Index
1A	SLD-1	300	3,114	14,374	11,026	NA	0	371,091	1062	17,363	5,852	26,563	372,808	119.72
1B	SLD-2	250	2,595	14,374	11,584	NA	0	309,242	885	14,469	4,876	22,135	310,674	119.72
1C	SLD-3	550	5,709	14,374	8,236	NA	0	680,333	1947	31,831	10,728	48,697	683,482	119.72

Rezoned street lighting parameters/operation

ID	Energy Resource Opportunity			No. of Units	Operating Schedule			Coincid. Peak Factor	Energy Consumption (kWh)			Sum of 12 Monthly Coincident demands (kW-mo)		
	Equip Code	ERO Description	Size (kW)		Hrs on-peak	Hrs mid-peak	Hrs off-peak		on-peak	mid-peak	off-peak	on-peak	mid-peak	off-peak
1D	SLO	Reduce OpHrs	0.295	1,288	844	NA	2,096	1.0	320,859	NA	796,486	4,560	NA	NA

Rezoned street lighting ERO economics

ID	Economic Parameters							First Year Energy & Demand Savings					Life Cycle Cost	
	Equip Code	No. of Units	First Cost (\$)	Before O&M \$	After O&M \$	Life Yr	Salvage \$	Energy (kWh)	Demand (kW-mo)	Energy (1992 \$)	Demand (1992 \$)	Total (1992 \$)	NPV \$	Value Index
1D	SLO	0	23,680	14,374	10,525	NA	0	406,265	0	17,800	0	21,649	287,385	12.14

Rezoned & delampd street lighting parameters/operation

ID	Energy Resource Opportunity			No. of Units	Operating Schedule			Coincid. Peak Factor	Energy Consumption (kWh)			Sum of 12 Monthly Coincident demands (kW-mo)		
	Equip Code	ERO Description	Size (kW)		Hrs on-peak	Hrs mid-peak	Hrs off-peak		on-peak	mid-peak	off-peak	on-peak	mid-peak	off-peak
1E	SLO,D-1	Red. OpHrs+SLD-	0.295	988	844	NA	2,388	1.0	320,859	NA	907,269	3,498	NA	NA
1F	SLO,D-2	Red. OpHrs+SLD-	0.295	1,038	844	NA	2,339	1.0	320,859	NA	888,805	3,675	NA	NA
1G	SLO,D-3	Red. OpHrs+SLD-	0.295	738	844	NA	2,631	1.0	320,859	NA	999,588	2,613	NA	NA

Rezoned & delampd street lighting ERO economics

ID	Economic Parameters							First Year Energy & Demand Savings					Life Cycle Cost	
	Equip Code	Qty	First Cost (\$)	Before O&M \$	After O&M \$	Life Yr	Salvage \$	Energy (kWh)	Demand (kW-mo)	Energy (1992 \$)	Demand (1992 \$)	Total (1992 \$)	NPV \$	Value Index
1E	SLO,D-1	300	26,794	14,374	7,864	NA	0	666,556	1062	30,308	5,852	42,670	577,767	21.56
1F	SLO,D-2	250	26,275	14,374	8,262	NA	0	623,178	885	28,223	4,876	39,211	529,371	20.15
1G	SLO,D-3	550	29,389	14,374	5,874	NA	0	846,533	1947	39,113	10,728	58,341	796,973	27.12

TABLE 2.15. Old Post Streetlighting EROs

Existing Street Light Parameters/Operation

ID	Existing Equipment			No. of Units	Operating Schedule			# Month On-Peak	Avg. Lo (kW/unit)	Energy Consumption (kWh)			Sum of 12 Monthly Coincident Demands (kW-m)		
	Equip Code	Lamp Type	Size (kW)		Hrs ON	Hrs MID	Hrs OFF			On-Peak	Mid-Peak	Off-Peak	On-Peak	Mid-Peak	Off-Peak
2	SLHg-1	Mercury Vapor	0.454	253	844	NA	3,348	12	0.454	96,996	NA	384,560	1,378	NA	NA

HPS Retrofit Parameters/Operation

ID	Energy Resource Opportunity			No. of Units	Operating Schedule			# Month On-Peak	Avg. Lo (kW/unit)	Energy Consumption (kWh)			Sum of 12 Monthly Coincident Demands (kW-m)		
	Equip Code	ERO Description	Size (kW)		Hrs ON	Hrs MID	Hrs OFF			On-Peak	Mid-Peak	Off-Peak	On-Peak	Mid-Peak	Off-Peak
2A	SLHPS-1	Upgrade to HPS-250	0.295	253	844	NA	3,348	12	0.300	64,094	NA	254,115	911	NA	NA
2B	SLHPS-2	Upgrade to HPS-200	0.240	253	844	NA	3,348	12	0.240	51,275	NA	203,292	729	NA	NA

HPS Retrofit ERO Economics

ID	Economic Parameters							First Year Energy & Demand Savings					Life Cycle Cost	
	Equip Code	No. of Units	First Cost	Before O&M \$	After O&M \$	Life Yr	Salvage \$	Energy (kWh)	Demand (kW-mo)	Energy (1992 \$)	Demand (1992 \$)	Total (1992 \$)	NPV \$	Value Index
2A	SLHPS-1	253	60,973	2,113	2,113	5	0	168,677	482	7,892	2,656	10,548	86,011	1.41
2B	SLHPS-2	253	54,395	2,292	2,292	5	0	227,024	649	10,622	3,576	14,198	141,345	2.60

2.9 FAN, PUMP, AND COMPRESSOR MOTOR EROs

Motor ERO analysis at Fort Drum considered two primary efficiency options. The first involves the replacement of a single-speed standard-efficiency motor with a high-efficiency model. The second considers the replacement of a single-speed motor with a two-speed motor where applicable.

This section addresses the fan and pump motors associated with HVAC systems in most types of New Post buildings and compressor motors that supply air in the vehicle maintenance shops and similar applications. Water and Sewer pumps are considered in Section 2.10. Discrete refrigerant compressors are not considered because they have high first cost per kW and represent a relatively small part of Fort Drum's energy consumption.

The replacement of currently installed standard efficiency motors with high-efficiency models was evaluated on both a replace-immediately (RI) and replace-on-failure (ROF) basis. Two-speed motors were considered in any application where a reduced level of operation is acceptable. This included cases of day/night or weekday/weekend operation and cases involving variable heating or cooling loads.

An inventory of motors larger than 1 hp was developed based on typical building types that represent large numbers of New Post buildings. Motor sizes, functions, and quantities were catalogued during site visits of these buildings. From this information and building type square footage, a total equipment count for the New Post was estimated.

Motors associated with Old Post buildings were generally integral parts of heating systems or too small to be considered individually. Old Post motors were therefore not considered in this analysis.

2.9.1 Energy-Efficient Motors

Energy-efficient, three-phase motors are manufactured with predominantly open drip proof (ODP) or total enclosed fan cooled (TEFC) enclosures. Motors up to 200 hp can be obtained in either 1200, 1800, or 3600 rpm. They are particularly attractive in duty-cycling applications because they suffer less thermal stress than standard efficient motors due to lower losses overall. There are some applications, however, in which energy-efficient motors (EEMs)

would not be a good alternative; namely, in situations where high starting torque is needed. This is because EEMs are optimized for low slip operation, which generally results in lower starting torque than for standard efficiency motors. For most HVAC fan and pump applications the starting torque is not an issue. However, the starting characteristics should be kept in mind in preparing retrofit specifications for such things as the compressor motors.

Description

This ERO considers the replacement of existing single-speed motors by the best currently available energy-efficient models. The majority of motors analyzed in this study fell under the duty-cycling or air-handling applications in which EEMs are clearly a viable option.

Because of their relatively low energy consumption, motors of less than 1 horsepower are not considered in this analysis. Motors that currently operate at two speeds are also not considered, because the efficiency improvement possible by replacing a two-speed motor with a high-efficiency model is relatively small.

Assumptions

Technical assumptions are as follows:

- The operation schedules shown on mechanical drawings for representative building types were generally considered to be accurate unless reported otherwise by base sources. For example, we were informed that many of the timeclock controls had been physically deactivated.
- Type, size and operation of motors within a building type are considered uniform among buildings of that building type.
- Existing motors were considered to be sized correctly for current operations. However, significant additional savings can probably be obtained by evaluating the size of each motor in relation to its load at the time of replacement. It is particularly important to check for fans and pumps that are producing higher flow rates than necessary and pumps that have been throttled with valves or flow regulators.

Cost estimating data are as follows:

- Maintenance costs for standard and high-efficiency motors are the same.

- Motor costs are based on the energy-efficient ODP motor costs reported in ACEEE (Nadel 1991, Table A.2).
- The cost of installation labor is \$132 for motors of 10 hp and less, \$221 for 15 to 30 hp, \$363 for 40 to 75 hp, and \$856 for motors over 75 hp.
- Motor life expectancy is 15 years.
- Salvage value of still-functional motors is 20% of a standard single-speed motor's new cost.

Results

Quantitative results of the energy-efficient motor ERO analysis are presented in Tables 2.16 through 2.28 (pp. 2.123- 2.135). All motors larger than 1 hp that exist in the indicated building types are listed in the first block of each table. Numbers pertaining to the subset of motors targeted for the energy efficient motor retrofit are presented in the next two blocks. The last two blocks of each table contain numbers pertaining to the two-speed motor retrofit, which is described in the next subsection.

Budget Implications. The first cost of all cost-effective energy-efficient motor retrofits is \$451,170, consisting of the immediate replacement implementations at \$307,700 and the replacement on failure measures at \$143,470.

Energy, Demand, and Cost Savings. The electric energy savings associated with all cost-effective implementations of this ERO are estimated to be 450,000 kWh per year at a cost savings of \$25,000 per year. Demand savings are estimated to be 2200 kW-months per year with a cost savings of over \$10,000 per year.

The results are reported by building type in the tables. The energy and demand numbers for the existing equipment are tabulated in the first sub-table of the table associated with each building type. A pair of sub-tables follow for each ERO considered for the building type. Typically, there is a pair of tables for the ERO to replace an existing motor with a high-efficiency motor and a pair of sub-tables for the ERO to replace the existing motor with a

two-speed motor. The energy and demand numbers for the replacement technology appear in the first sub-table of each pair, and the savings numbers appear in the second.

Energy or Operations Security. This ERO has no impact on energy or operations security. The recommended motor replacements are one-for-one retrofits that do not inhibit operations or energy supply.

Operations and Maintenance. The impact of this ERO on maintenance is considered to be negligible. Newer, higher-efficiency motors should have no increased maintenance costs. In practice they may even require less maintenance.

Environmental Implications. This ERO has no direct environmental impact.

2.9.2 Two-Speed Motors

Two-speed, three-phase motors are manufactured with predominately ODP or TEFC enclosures. Motors up to 500 hp can be obtained for a variety of applications. They are particularly attractive in applications where 1) variable heating or cooling loads result in flow requirements below two-thirds or one-half of peak required flow a large fraction of the time, or 2) flow requirements vary with day/night or weekday/weekend activity. Some of the drawbacks to two-speed motors include the design trade-offs that inevitably make a two-speed motor somewhat less efficient than its single-speed counterpart. However, in many applications, the percentage of time the motor is running in low speed makes the two-speed motor more attractive than an energy-efficient single-speed motor.

Description

Single-speed motors larger than 1 hp that are used in applications where two-speed operation would be advantageous have been considered for replacement. Because of their relatively low energy consumption, motors of less than 1 hp are not considered in this analysis.

Assumptions

Technical assumptions are as follows:

- The operation schedules shown on mechanical drawings for representative building types were generally considered to be accurate unless we were otherwise informed by base sources. For example, we were informed that many of the timeclock controls had been physically deactivated.
- Type, size, and operation of motors within a building type are considered uniform among buildings of that building type.
- The distribution of low and high-speed operating times for two-speed motor applications is 10% at high speed and 90% at low speed unless otherwise noted in the tables.
- Existing motors were considered to be sized correctly for current operations. However, significant additional savings can probably be obtained by evaluating the size of each motor in relation to its load at the time of replacement. It is particularly important to check for fans and pumps that are producing higher flow rates than necessary and pumps that have been throttled with valves or flow regulators.

Cost estimating parameters are as follows:

- Maintenance costs for the two-speed retrofit were assumed to be \$10 per motor more than for the existing single-speed motors; this additional cost is for the maintenance of additional controls associated with the two-speed operation.
- Two-speed motor controllers cost \$100 each. The motor cost is based on the cost of standard single-speed motors reported in ACEEE (1991). The two-speed motor is taken to cost 1.5 times the cost of a comparable, standard-efficiency, single-speed motor.
- The cost of installation labor is \$132 for motors of 10 hp and less, \$221 for 15 to 30 hp, \$363 for 40 to 75 hp, and \$856 for motors over 75 hp.
- Motor life expectancy is 15 years.
- The salvage value of still-functional motors is 20% of a standard single-speed motor's new cost.

Results

Quantitative results of the two-speed motor ERO analysis are presented in Tables 2.16 through 2.28. All motors larger than 1 hp that exist in the indicated building type are listed in the first block of each table. Numbers pertaining to the subset of motors targeted for the energy efficient motor

retrofit are presented in the next two blocks. Numbers pertaining to the subset of motors targeted for the two-speed motor retrofit are presented in the last two blocks.

Budget Implications. The first cost of the immediate replacement EROs is \$527,225 and the "replacement on failure" measures cost \$2,705, for a total cost of just under \$530,000.

Energy, Demand, and Cost Savings. The electric energy savings associated with all cost-effective implementations of this ERO are estimated to be 3,200,000 kWh per year at a cost savings of \$169,000 per year. The demand will increase slightly rather than decrease, as a result of this ERO. The increase in demand is estimated to be 2600 kW-months per year at a cost of \$14,000 per year.

Energy and Operations Security. This ERO has no impact on energy security. The recommended motor replacements are one-for-one retrofits that do not inhibit operations or energy supply.

Operations and Maintenance. The additional maintenance associated with this ERO is small but not negligible. Controls for the replacement two-speed motors will have a finite failure rate that is reflected in the estimated maintenance costs.

Environmental Implications. This ERO has no direct environmental impact.

TABLE 2.16. Motor EROs in Administration (ADM Type) Buildings

Existing Motor Operating Parameters

ID	Existing Equipment			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum Monthly Peak Coincident	On-Peak	Mid-Peak
1	MF-1.5	AHU Fan	1.5	12,531	714,269	57	800	NA	1,200	9	NA	51,026	NA	76,540	741.7	NA	NA
2	MF-1.5	AHU Fan	1.5	12,531	714,269	57	1,000	NA	1,500	9	NA	63,783	NA	95,675	741.7	NA	NA
3	MF-1.67	Toilet EXH	1/8	6,211	714,269	115	2,000	NA	0	8	NA	28,597	NA	0	153.8	NA	NA
4	MF-5:08	Conf. EXH	1/2-1/12	4,129	714,269	173	520	NA	0	3	10	8,389	NA	0	257.4	NA	NA
5	MF-5:33	Equip. Room	1/2-1/3	12,531	714,269	57	525	NA	225	3	10	7,806	NA	3,346	84.8	NA	NA
6	MF-5:1.2	Attic EXH	5-1.2	4,129	714,269	173	560	NA	240	3	10	114,190	NA	48,939	2,326.8	NA	NA
7	MF-7.5:1.7	Summer Ven	7.5-1.7	4,129	714,269	173	680	NA	1,020	3	10	200,092	NA	300,137	3,404.2	NA	NA
8	MF-5:1.2	SF Summer	5-1.2	12,531	714,269	57	680	NA	1,020	3	10	45,686	NA	68,528	766.6	NA	NA
9	MF-5	SF Gen. Vent	0.5	12,531	714,269	57	1,750	NA	0	9	NA	37,207	NA	0	254.5	NA	NA
10	MP-083	DHW Pumps	1/12	12,531	714,269	57	800	NA	1,200	12	NA	2,835	NA	4,252	57.0	NA	NA
11	MP-2	HW Pumps	2	6,211	714,269	115	600	NA	900	6	NA	102,948	NA	154,422	1,311.4	NA	NA
12	MAC-5	Air Comp.	0.5	12,531	714,269	57	560	NA	240	4	NA	11,906	NA	5,103	113.1	NA	NA

Energy-efficient motor operating parameters

ID	Energy Resource Opportunity			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum Monthly Peak Coincident	On-Peak	Mid-Peak
1A	MFE-1.5	AHU Fan	1.5	12,531	714,269	57	800	NA	1,200	9	NA	47,287	NA	70,931	682.6	NA	NA
2A	MFE-1.5	AHU Fan	1.5	12,531	714,269	57	1,000	NA	1,500	9	NA	59,109	NA	88,664	682.6	NA	NA
11	MPE-2	HW Pumps	2	6,211	714,269	115	600	NA	900	6	NA	96,048	NA	144,072	1,216.9	NA	NA

Energy-efficient motor ERO economic parameters

ID	Economic Parameters						First Year Savings					Life Cycle Cost		
	First Cost \$ RI	First Cost \$ ROF	Before O&M \$	After O&M \$	Life Yr	Salvage \$ RI	Energy kWh	Deman kW-mos	Energy \$	Demand \$	Total \$	When	NPV \$	Value Index
1A	17,841	10,400	0	0	15	1,664	9,348	59	254	178	432	ROF	3,194	0.31
2A	17,841	10,400	0	0	15	1,664	11,685	59	318	178	496	ROF	3,818	0.37
11	37,950	22,122	0	0	15	3,657	17,250	95	469	285	753	ROF	5,041	0.23

2-speed motor operating parameters

The 2-speed ERO is not applicable to these ADM buildings

TABLE 2.17. Motor EROs in Assembly (ASS Type) Buildings

Existing motor operating parameters

ID	Existing Equipment			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum	Monthly Peak Coinc	On-Peak Mid-Peak Off-P.
1	MF-03	Cab Htr	0.030	4,990	39,920	8	720	NA	1,080	6	NA	143	NA	215	1.4	NA	NA
2	MF-05	Cab Htr	0.050	4,990	39,920	8	720	NA	1,080	6	NA	215	NA	322	2.4	NA	NA
3	MF-17	Cab Htr	0.167	9,980	39,920	4	720	NA	1,080	6	NA	358	NA	537	4.0	NA	NA
4	MF-17	EXH Fan	0.167	9,980	39,920	4	1,000	NA	0	9	NA	497	NA	0	6.0	NA	NA
5	MF-25	EXH Fan	0.250	9,980	39,920	4	2,000	NA	0	9	NA	1,492	NA	0	9.0	NA	NA
6	MF-33	EXH Fan	0.333	9,980	39,920	4	1,000	NA	0	9	NA	995	NA	0	12.0	NA	NA
7	MF-10	Return Fan	10	4,990	39,920	8	520	NA	780	3	NA	31,034	NA	46,550	207.5	NA	NA
8	MF-10	AHU Fan	10	9,980	39,920	4	560	NA	840	9	NA	16,710	NA	25,068	311.2	NA	NA
9	MF-15	AHU Fan	15	9,980	39,920	4	560	NA	840	9	NA	25,068	NA	37,598	462.0	NA	NA
10	MP-5	Prim Pump	5	9,980	39,920	4	520	NA	780	12	NA	7,758	NA	11,638	215.2	NA	NA
11	MP-5	Sec. Pump	5	9,980	39,920	4	200	NA	0	3	NA	2,984	NA	0	53.8	NA	NA
12	MP-05	Circ. Pump	0.050	9,980	39,920	4	3,504	NA	5,256	12	NA	523	NA	784	2.4	NA	NA

Energy-efficient motor operating parameters

ID	Energy Resource Opportunity			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum	Monthly Peak Coinc	On-Peak Mid-Peak Off-P.
7	MFE-10	Return Fan	10	4,990	39,920	8	520	NA	780	3	NA	29,786	NA	44,678	198	NA	NA
8	MFE-10	AHU Fan	10	9,980	39,920	4	560	NA	840	9	NA	16,038	NA	24,058	297	NA	NA
9	MFE-15	AHU Fan	15	9,980	39,920	4	560	NA	840	9	NA	24,013	NA	36,019	441	NA	NA
10	MPE-5	Prim Pump	5	9,980	39,920	4	520	NA	780	12	NA	7,363	NA	11,045	203	NA	NA
11	MPE-5	Sec. Pump	5	9,980	39,920	4	200	NA	0	3	NA	2,832	NA	0	51	NA	NA

Energy-efficient motor ERO economic parameters

ID	Economic Parameters						First Year Savings					Life Cycle Cost		
	First Cost \$ RI	First Cost \$ ROF	Before O&M \$	After O&M \$	Life Yr	Salvage \$ RI	Energy kWh	Demand kW-mos	Energy \$	Demand \$	Total \$	When	NPV \$	Value Index
7	4,160	2,425	0	0	15	480	3,120	9	85	28	113	ROF	788	0.32
8	2,080	1,213	0	0	15	240	1,680	14	84	78	161	RI	316	0.15
9	2,992	1,744	0	0	15	318	2,632	21	131	115	245	RI	639	0.21
10	1,452	846	0	0	15	143	988	12	49	67	116	RI	294	0.20
11	1,452	846	0	0	15	143	152	3	5	9	14	ROF	30	0.04

2-speed motor operating parameters

ID	Energy Resource Opportunity			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum	Monthly Peak Coinc	On-Peak Mid-Peak Off-P.
7	MF-10:2.5	Return Fan	10/2.5	4,990	39,920	8	520	NA	780	3	10	14,042	NA	21,062	218.4	NA	NA
8	MF-10:2.5	AHU Fan	10/2.5	9,980	39,920	4	560	NA	840	9	10	7,561	NA	11,341	327.6	NA	NA
9	MF-15:3.75	AHU Fan	15/3.75	9,980	39,920	4	560	NA	840	9	10	11,483	NA	17,224	486.3	NA	NA
10	MP-5:1.2	Prim Pump	5/1.2	9,980	39,920	4	520	NA	780	12	10	3,700	NA	5,550	239.1	NA	NA
11	MP-5:1.2	Sec. Pump	5/1.2	9,980	39,920	4	200	NA	0	3	10	1,423	NA	0	59.8	NA	NA

2-speed motor ERO economic parameters

ID	Economic Parameters						First Year Savings					Life Cycle Cost		
	First Cost \$ RI	First Cost \$ ROF	Before O&M \$	After O&M \$	Life Yr	Salvage \$ RI	Energy kWh	Demand kW-mos	Energy \$	Demand \$	Total \$	When	NPV \$	Value Index
7	6,856	3,997	0	80	15	480	42,480	(11)	2,112	(60)	2,052	RI	20,148	2.94
8	3,428	1,998	0	40	15	240	22,874	(16)	1,137	(90)	1,047	RI	10,345	3.02
9	4,516	2,633	0	40	15	318	33,957	(24)	1,689	(134)	1,555	RI	16,385	3.63
10	2,552	1,488	0	40	15	143	10,146	(24)	505	(132)	373	RI	1,804	0.71
11	2,552	1,488	0	40	15	143	1,561	(6)	50	(18)	32	ROF	(599)	-0.40

TABLE 2.18. Motor EROs in Barracks (BAR Type) Buildings

Existing Motor Operating Parameters

ID	Existing Equipment			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum Monthly Peak Coincident	On-Peak	Mid-Peak
1	MF-1.25:7	Attic EXH	1.25/7	8,750	1,102,549	128	770	NA	330	3	0.1	54,645	NA	23,419	458.7	NA	NA
2	MF-1.25:7	Toilet EXH	1.25/7	28,251	1,102,549	42	2,080	NA	0	12	0.1	122,521	NA	0	611.8	NA	NA
3	MF-1	Supply Fan	1	13,128	1,102,549	84	880	NA	1,320	9	NA	55,144	NA	82,716	739.2	NA	NA
4	MF-5	AHU-5,6	5	28,251	1,102,549	42	2,100	NA	0	9	NA	328,988	NA	0	1694.8	NA	NA
5	MF-5	AHU-1,2,3	5	17,501	1,102,549	63	1,200	NA	1,800	9	NA	281,988	NA	422,982	2542.0	NA	NA
6	MF-5	AHU-4	5	52,502	1,102,549	21	1,200	NA	1,800	9	NA	93,998	NA	140,994	847.3	NA	NA
7	MP-2	Sup Wtr Pm	2	28,251	1,102,549	42	1,000	NA	1,500	4	NA	82,664	NA	93,998	319.3	NA	NA
8	MP-5	Sup Wtr Pm	5	28,251	1,102,549	42	1,000	NA	1,500	4	NA	156,680	NA	234,990	753.2	NA	NA
9	MF-5:1.2	Sum Vent	5/1.2	7,500	1,102,549	147	880	NA	1,320	3	0.25	207,481	NA	311,221	1977.1	NA	NA
10	MF-5:1.2	Gen. EXH	5/1.2	13,128	1,102,549	84	1,820	NA	780	9	0.25	245,204	NA	105,088	3389.3	NA	NA
11	MF-5:1.2	Gen. EXH	5/1.2	52,502	1,102,549	21	1,200	NA	1,800	9	0.25	40,418	NA	80,628	847.3	NA	NA
12	MF-2:5	EXH Fans	2/5	13,128	1,102,549	84	2,080	NA	0	9	0.25	114,048	NA	0	1436.9	NA	NA
13	MF-2:5	EXH Fans	2/5	28,251	1,102,549	42	2,080	NA	0	9	0.25	57,024	NA	0	718.4	NA	NA

Energy-efficient motor operating parameters

ID	Energy Resource Opportunity			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum Monthly Peak Coincident	On-Peak	Mid-Peak
3A	MFE-1	Supply Fan	1	13,128	1,102,549	84	880	NA	1,320	9	NA	50,413	NA	75,620	874.8	NA	NA
4A	MFE-5	AHU-5,6	5	28,251	1,102,549	42	2,100	NA	0	9	NA	312,228	NA	0	1598.8	NA	NA
5A	MFE-5	AHU-1,2,3	5	17,501	1,102,549	63	1,200	NA	1,800	9	NA	287,824	NA	401,438	2397.9	NA	NA
6A	MFE-5	AHU-4	5	52,502	1,102,549	21	1,200	NA	1,800	9	NA	88,208	NA	133,812	799.3	NA	NA
7A	MPE-2	Sup Wtr Pm	2	28,251	1,102,549	42	1,000	NA	1,500	4	NA	58,464	NA	87,698	298.3	NA	NA
8A	MPE-5	Sup Wtr Pm	5	28,251	1,102,549	42	1,000	NA	1,500	4	NA	148,680	NA	223,020	710.5	NA	NA

Energy-efficient motor ERO economic parameters

ID	Economic Parameters						First Year Savings					Life Cycle Cost		
	First Cost \$ RI	First Cost \$ ROF	Before O&M \$	After O&M \$	Life Yr	Salvage \$ RI	Energy kWh	Demand kW-mos	Energy \$	Demand \$	Total \$	When	NPV \$	Value Index
3A	24,864	14,494	0	0	15	2,218	11,827	65	321	195	518	ROF	3,654	0.25
4A	15,248	8,887	0	0	15	1,504	16,758	98	982	529	1,511	RI	7,159	0.47
5A	22,869	13,331	0	0	15	2,255	35,913	144	1,788	794	2,580	RI	15,152	0.68
6A	7,623	4,444	0	0	15	752	11,970	48	583	264	858	RI	5,023	0.66
7A	13,860	8,079	0	0	15	1,338	10,500	23	285	69	355	ROF	2,622	0.32
8A	15,248	8,887	0	0	15	1,504	19,950	43	992	235	1,227	RI	3,189	0.21

2-speed motor operating parameters

ID	Energy Resource Opportunity			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum Monthly Peak Coincident	On-Peak	Mid-Peak
4B	MF-5:1.2	AHU-5,6	5/1.2	28,251	1,102,549	42	2,100	NA	0	9	10	158,886	NA	0	1882.9	NA	NA
5B	MF-5:1.2	AHU-1,2,3	5/1.2	17,501	1,102,549	63	1,200	NA	1,800	9	10	134,474	NA	201,711	2824.4	NA	NA
6B	MF-5:1.2	AHU-4	5/1.2	52,502	1,102,549	21	1,200	NA	1,800	9	10	44,825	NA	87,237	941.5	NA	NA
7B	MP-2:5	Sup Wtr Pm	2/5	28,251	1,102,549	42	1,000	NA	1,500	4	10	28,690	NA	43,035	354.8	NA	NA
8B	MF-5:1.2	Sup Wtr Pm	5/1.2	28,251	1,102,549	42	1,000	NA	1,500	4	10	74,708	NA	112,061	836.9	NA	NA

2-speed motor ERO economic parameters

ID	Economic Parameters						First Year Savings					Life Cycle Cost		
	First Cost \$ RI	First Cost \$ ROF	Before O&M \$	After O&M \$	Life Yr	Salvage \$ RI	Energy kWh	Demand kW-mos	Energy \$	Demand \$	Total \$	When	NPV \$	Value Index
4B	26,798	15,620	0	420	15	1,504	(18,025)	(1,144)	10,083	(1,038)	9,046	RI	91,172	3.40
5B	40,194	23,430	0	630	15	2,255	(7,198)	(1,130)	18,339	(1,556)	16,783	RI	182,004	4.53
6B	13,398	7,810	0	210	15	752	592,908	1,600	8,111	(519)	5,592	RI	60,838	4.53
7B	24,591	14,335	0	420	15	1,338	163,265	483	4,224	(196)	4,028	RI	23,129	0.94
8B	26,798	15,620	0	420	15	1,504	(30,108)	(518)	10,188	(481)	9,707	RI	100,783	3.78

TABLE 2.19. Motor EROs in Club (CLB Type) Buildings

Existing Motor Operating Parameters

ID	Existing Equipment			Density SqFt/Mtr	Total SqFt	# of Motors	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum Monthly Peak Coincident		
1	MF-5	AHU-1	0.5	18,786	58,358	3	1,750	NA	750	9	NA	1,958	NA	839	13.4	NA	NA
2	MF-5-2.2	AHU-2	5-2.2	18,786	58,358	3	1,000	NA	1,500	9	25	8,490	NA	9,738	121.0	NA	NA
3	MF-5-2.2	AHU-2	5-2.2	18,786	58,358	3	800	NA	1,200	9	10	4,440	NA	8,690	121.0	NA	NA
4	MF-3-1.75	AHU-3	3-7.5	18,786	58,358	3	1,000	NA	1,500	9	10	2,182	NA	3,273	75.0	NA	NA
5	MF-3-1.75	AHU-3	3-7.5	18,786	58,358	3	1,000	NA	1,500	9	10	2,182	NA	3,273	75.0	NA	NA
6	MF-10-2.5	AHU-4	10-2.5	18,786	58,358	3	1,000	NA	1,500	9	10	7,274	NA	10,910	233.4	NA	NA
7	MF-10-2.5	AHU-4	10-2.5	18,786	58,358	3	800	NA	1,200	9	10	5,819	NA	8,728	233.4	NA	NA
8	MF-7.5-2.3	AHU-5	7.5-2.3	18,786	58,358	3	1,200	NA	1,800	9	10	7,574	NA	11,380	177.1	NA	NA
9	MF-7.5-2.3	AHU-5	7.5-2.3	18,786	58,358	3	1,200	NA	1,800	9	10	7,574	NA	11,380	177.1	NA	NA
10	MF-5	AHU-6	0.5	18,786	58,358	3	1,200	NA	1,800	9	NA	480	NA	690	13.4	NA	NA
11	MF-5	Toilet EXH	0.5	9,393	58,358	6	2,080	NA	0	12	NA	4,655	NA	0	35.7	NA	NA
12	MF-1-1.25	Equip. room	1-2.5	18,786	58,358	3	784	NA	328	3	10	556	NA	238	8.8	NA	NA
13	MF-5-2.2	Atmc Vent.	5-2.2	9,393	58,358	6	800	NA	1,200	3	33	11,216	NA	18,825	80.7	NA	NA
14	MF-5-2.2	Gen. Vent.	5-2.2	18,786	58,358	3	1,750	NA	750	9	25	11,358	NA	4,868	121.0	NA	NA
15	MF-3-1.75	Gen. Vent.	3-7.5	18,786	58,358	3	1,750	NA	750	9	25	5,141	NA	2,203	75.0	NA	NA
16	MF-3-1.75	Dish Wash Fa	3-7.5	9,393	58,358	6	800	NA	1,200	8	25	4,700	NA	7,050	133.3	NA	NA
17	MF-33	Storage Fan	0.33	9,393	58,358	6	1,200	NA	1,800	6	NA	1,772	NA	2,659	12.0	NA	NA
18	MP-1.5	Ref Comp	1.5	6,262	58,358	9	800	NA	1,200	3	NA	8,057	NA	12,085	39.0	NA	NA
19	MP-1	Pump	1	18,786	58,358	3	800	NA	1,200	3	NA	1,790	NA	2,686	8.8	NA	NA
20	MAC-5	AC Comp.	0.5	18,786	58,358	3	900	NA	0	3	NA	1,007	NA	0	4.5	NA	NA
21	MAC-1	AC Comp.	1	9,393	58,358	6	900	NA	0	3	NA	4,028	NA	0	17.6	NA	NA

Energy-efficient motor operating parameters

ID	Energy Resource Opportunity			Density SqFt/Mtr	Total SqFt	# of Motors	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum Monthly Peak Coincident		
18	MPE-1.5	Ref Comp	1.5	6,262	58,358	9	800	NA	1,200	3	NA	7,468	NA	11,200	35.9	NA	NA
19	MPE-1	Pump	1	18,786	58,358	3	800	NA	1,200	3	NA	1,837	NA	2,455	8.0	NA	NA
21	MACE-1	AC Comp.	1	9,393	58,358	6	900	NA	0	3	NA	3,683	NA	0	16.1	NA	NA

Energy-efficient motor ERO economic parameters

ID	Economic Parameters						First Year Savings					Life Cycle Cost		
	First Cost \$ RI	First Cost \$ ROF	Before O&M \$	After O&M \$	Life Yr	Salvage \$ RI	Energy kWh	Demand kW-mos	Energy \$	Demand \$	Total \$	When	NPV \$	Value Index
18	2,817	1,642	0	0	15	263	1,478	3	40	9	49	ROF	320	0.19
19	888	518	0	0	15	79	384	1	10	2	13	ROF	76	0.15
21	1,776	1,035	0	0	15	158	345	2	11	5	16	ROF	52	0.05

2-speed motor operating parameters

The 2-speed ERO is not applicable to these CLB buildings

TABLE 2.20. Motor EROs in Clinic (CLINIC Type) Buildings

Existing motor operating parameters

ID	Existing Equipment			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum	Monthly Peak Coincident	Off-Peak
1	MP-1	Chill Cond	1	8,180	18,480	3	700	NA	300	3	NA	1,587	NA	871	8.8	NA	NA
2	MP-5	Chill Supply	5	9,240	18,480	2	700	NA	300	3	NA	5,222	NA	2,238	26.9	NA	NA
3	MF-33	EDH Fan	0.333	4,820	18,480	4	2,000	NA	0	9	NA	1,989	NA	0	12.0	NA	NA
4	MF-2	AHU Fan	2	18,480	18,480	1	800	NA	1,200	9	NA	1,194	NA	1,790	17.1	NA	NA
5	MF-5	AHU Fan	5	18,480	18,480	1	800	NA	1,200	9	NA	2,984	NA	4,478	40.3	NA	NA
6	MF-10	AHU Fan	10	9,240	18,480	2	800	NA	1,200	9	NA	11,936	NA	17,904	155.8	NA	NA
7	MP-22	Chiller Comp	22	18,480	18,480	1	700	NA	300	3	NA	11,488	NA	4,924	50.9	NA	NA
8	MP-34	Chiller Comp	34	9,240	18,480	2	700	NA	300	3	NA	35,510	NA	15,218	150.4	NA	NA
9	MP-7.5	Vac Pump	7.5	9,240	18,480	2	800	NA	1,200	3	NA	8,952	NA	13,428	38.4	NA	NA
10	MP-25	Vac Pump	25	18,480	18,480	1	1,400	NA	600	3	NA	28,110	NA	11,190	82.9	NA	NA
11	MP-8	EDH Fan	5	9,240	18,480	2	2,000	NA	0	9	NA	14,920	NA	0	80.7	NA	NA
12	MP-7.5	HTHW Pump	7.5	9,240	18,480	2	1,000	NA	1,500	6	NA	11,190	NA	16,785	78.7	NA	NA

Energy-efficient motor operating parameters

ID	Energy Resource Opportunity			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum	Monthly Peak Coincident	Off-Peak
1A	MPE-1	Chiller Cond	1	8,180	18,480	3	700	NA	300	3	NA	1,432	NA	814	8.0	NA	NA
2A	MPE-5	Chill Supply	5	9,240	18,480	2	700	NA	300	3	NA	4,956	NA	2,124	25.4	NA	NA
4A	MFE-2	AHU Fan	2	18,480	18,480	1	800	NA	1,200	9	NA	1,114	NA	1,670	15.9	NA	NA
5A	MFE-5	AHU Fan	5	18,480	18,480	1	800	NA	1,200	9	NA	2,832	NA	4,248	38.1	NA	NA
6A	MFE-10	AHU Fan	10	9,240	18,480	2	800	NA	1,200	9	NA	11,456	NA	17,184	148.5	NA	NA
7A	MPE-22	Chiller Comp	22	18,480	18,480	1	700	NA	300	3	NA	11,075	NA	4,747	48.6	NA	NA
8A	MPE-34	Chiller Comp	34	9,240	18,480	2	700	NA	300	3	NA	34,474	NA	14,774	144.1	NA	NA
9A	MPE-7.5	Vac Pump	7.5	9,240	18,480	2	800	NA	1,200	3	NA	8,536	NA	12,804	37.3	NA	NA
10	MPE-25	Vac Pump	25	18,480	18,480	1	1,400	NA	600	3	NA	25,144	NA	10,776	80.2	NA	NA
11	MFE-5	EDH Fan	5	9,240	18,480	2	2,000	NA	0	9	NA	14,180	NA	0	76.1	NA	NA
12	MPE-7.5	HTHW Pump	7.5	9,240	18,480	2	1,000	NA	1,500	6	NA	10,670	NA	16,005	74.7	NA	NA

Energy-efficient motor ERO economic parameters

ID	Economic Parameters						First Year Savings					Life Cycle Cost		
	First Cost \$ R	First Cost \$ ROF	Before O&M \$	After O&M \$	Life Yr	Salvage \$ R	Energy kWh	Demand kW-mos	Energy \$	Demand \$	Total \$	When	NPV \$	Value Index
1A	888	518	0	0	15	78	192	1	6	2	8	ROF	29	0.08
2A	728	423	0	0	15	72	380	2	11	5	18	ROF	100	0.24
4A	330	192	0	0	15	32	200	1	5	4	9	ROF	58	0.38
5A	363	212	0	0	15	36	380	2	19	12	31	R	101	0.28
6A	1,040	606	0	0	15	120	1,200	7	80	39	99	R	414	0.40
7A	868	508	0	0	15	99	590	2	17	7	24	ROF	181	0.32
8A	2,190	1,277	0	0	15	275	1,480	6	44	19	63	ROF	421	0.33
9A	918	535	0	0	15	96	1,040	2	52	12	63	R	19	0.02
10	963	573	0	0	15	118	1,380	3	75	15	90	R	335	0.34
11	728	423	0	0	15	72	780	5	45	25	70	R	312	0.43
12	918	535	0	0	15	96	1,300	4	55	22	87	R	348	0.38

2-speed motor operating parameters

ID	Energy Resource Opportunity			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum	Monthly Peak Coincident	Off-Peak
2B	MP-5:1.2	Chill Supply	5/1.2	9,240	18,480	2	700	NA	300	3	10	2,480	NA	1,087	29.9	NA	NA
4B	MF-2:5	AHU Fan	2/5	18,480	18,480	1	800	NA	1,200	9	10	546	NA	820	19.0	NA	NA
5B	MF-5:1.2	AHU Fan	5/1.2	18,480	18,480	1	800	NA	1,200	9	10	1,423	NA	2,135	44.8	NA	NA
6B	MF-10:2.5	AHU Fan	10/2.5	9,240	18,480	2	800	NA	1,200	9	10	5,401	NA	8,101	163.8	NA	NA
11	MF-5:1.2	EDH Fan	5/1.2	9,240	18,480	2	2,000	NA	0	9	10	7,115	NA	0	89.7	NA	NA
12	MP-7.5:2.3	HTHW Pump	7.5/2.3	9,240	18,480	2	1,000	NA	1,500	6	10	5,562	NA	8,372	82.9	NA	NA

2-speed motor ERO economic parameters

ID	Economic Parameters						First Year Savings					Life Cycle Cost		
	First Cost \$ Rl	First Cost \$ ROF	Before O&M \$	After O&M \$	Life Yr	Salvage \$ Rl	Energy kWh	Demand kW-mos	Energy \$	Demand \$	Total \$	When	NPV \$	Value Index
2B	1,278	654	0	20	15	72	3,903	(3)	211	(17)	195	Rl	1,021	0.80
4B	586	295	0	10	15	32	1,818	(2)	80	(10)	70	Rl	185	0.32
5B	638	327	0	10	15	36	3,902	(5)	194	(25)	169	Rl	1,521	2.38
6B	1,714	850	0	20	15	120	16,338	(8)	812	(45)	767	Rl	8,603	5.02
11	1,278	654	0	20	15	72	7,806	(9)	457	(50)	408	Rl	4,017	3.15
12	1,497	753	0	20	15	96	14,021	(4)	697	(23)	674	Rl	7,527	5.03

TABLE 2.21. Motor EROs in Dry Good Retail (DGR Type) Buildings

Existing motor operating parameters

ID	Existing Equipment			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum Monthly Peak Coincident	On-Peak	Mid-Peak
1	MP-10	Chill Pump	10	38,458	115,375	3	740	NA	1,110	3	NA	18,581	NA	24,842	77.8	NA	NA
2	MP-50	Chiller	50	38,458	115,375	3	740	NA	1,110	3	NA	82,808	NA	124,209	369.3	NA	NA
3	MP-60	Chiller	60	38,458	115,375	3	740	NA	1,110	3	NA	98,387	NA	149,051	441.2	NA	NA
4	MF-5	AHU Fan	5	115,375	115,375	1	1,800	NA	2,400	9	NA	5,968	NA	8,952	40.3	NA	NA
5	MF-7.5	AHU Fan	7.5	115,375	115,375	1	1,800	NA	2,400	9	NA	6,952	NA	13,428	59.0	NA	NA
6	MF-10	AHU Fan	10	115,375	115,375	1	1,800	NA	2,400	9	NA	11,938	NA	17,904	77.8	NA	NA
7	MP-10	HTHW Pump	10	38,458	115,375	3	1,800	NA	2,400	6	NA	35,808	NA	53,712	155.8	NA	NA
8	MP-8	Dom. Wtr Htr	8	115,375	115,375	1	1,800	NA	2,400	12	NA	9,549	NA	14,323	78.7	NA	NA
9	MF-1	Cond Fan Ch	1	5,244	115,375	22	600	NA	900	3	NA	9,847	NA	14,771	64.5	NA	NA

Energy-efficient motor operating parameters

Energy Efficient Motor Operating Parameters																	
ID	Energy Resource Opportunity			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum Monthly Peak Coincident	On-Peak	Mid-Peak
1A	MPE-10	Chill Pump	10	38,458	115,375	3	740	NA	1,110	3	NA	15,895	NA	23,843	74.3	NA	NA
2A	MPE-50	Chiller	50	38,458	115,375	3	740	NA	1,110	3	NA	80,588	NA	120,878	357.5	NA	NA
3A	MPE-60	Chiller	60	38,458	115,375	3	740	NA	1,110	3	NA	98,703	NA	145,055	427.2	NA	NA
4A	MFE-5	AHU Fan	5	115,375	115,375	1	1,800	NA	2,400	9	NA	5,684	NA	8,498	38.1	NA	NA
5A	MFE-7.5	AHU Fan	7.5	115,375	115,375	1	1,800	NA	2,400	9	NA	8,538	NA	12,804	58.0	NA	NA
6A	MFE-10	AHU Fan	10	115,375	115,375	1	1,800	NA	2,400	9	NA	11,458	NA	17,184	74.3	NA	NA
7A	MPE-10	HTHW Pump	10	38,458	115,375	3	1,800	NA	2,400	6	NA	34,368	NA	51,552	148.5	NA	NA
8A	MPE-8	Dom. Wtr Htr	8	115,375	115,375	1	1,800	NA	2,400	12	NA	9,133	NA	13,899	74.7	NA	NA
9A	MFE-1	Cond Fan Ch	1	5,244	115,375	22	600	NA	900	3	NA	9,002	NA	13,504	58.9	NA	NA

Energy-efficient motor ERO economic parameters

ID	Economic Parameters						First Year Savings					Life Cycle Cost			
	First Cost \$ RI	First Cost \$ ROF	Before O&M \$	After O&M \$	Life Yr	Salvage \$ RI	Energy kWh	Demand kW-mos	Energy \$	Demand \$	Total \$	When	NPV \$	Value Index	
1A	1,580	909	0	0	15	180	1,665	4	45	11	58	ROF	409	0.45	
2A	4,497	2,821	0	0	15	613	5,550	12	276	65	341	RI	572	0.13	
3A	5,412	3,155	0	0	15	789	6,660	14	331	77	408	RI	673	0.12	
4A	383	212	0	0	15	38	760	2	38	12	50	RI	387	1.01	
5A	459	268	0	0	15	48	1,040	3	52	17	68	RI	525	1.14	
6A	520	303	0	0	15	60	1,200	4	60	19	79	RI	623	1.20	
7A	1,560	909	0	0	15	180	3,800	7	179	39	218	RI	1,608	1.03	
8A	459	268	0	0	15	48	1,040	4	52	22	74	RI	602	1.31	
9A	6,512	3,798	0	0	15	581	2,112	6	57	17	74	ROF	359	0.09	

2-speed motor operating parameters

Energy Resource Opportunity																	
ID	Equip Code	Type of Motor	Rating HP	Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
							Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum Monthly Peak Coincident	On-Peak	Mid-Peak
1B	MP-10:2.5	Chill Pump	10/2.5	38,458	115,375	3	740	NA	1,110	3	10	7,493	NA	11,240	81.9	NA	NA
4B	MF-5:1.2	AHU Fan	5/1.2	115,375	115,375	1	1,800	NA	2,400	9	10	2,848	NA	4,269	44.8	NA	NA
5B	MF-7.5:2.3	AHU Fan	7.5/2.3	115,375	115,375	1	1,800	NA	2,400	9	10	4,465	NA	6,698	62.1	NA	NA
6B	MF-10:2.5	AHU Fan	10/2.5	115,375	115,375	1	1,800	NA	2,400	9	10	5,401	NA	8,101	81.9	NA	NA
7B	MP-10:2.5	HTHWP Pump	10/2.5	38,458	115,375	3	1,800	NA	2,400	6	10	18,202	NA	24,303	163.6	NA	NA

2-speed motor ERO economic parameters

ID	Economic Parameters						First Year Savings					Life Cycle Cost			
	First Cost \$ RI	First Cost \$ ROF	Before O&M \$	After O&M \$	Life Yr	Salvage \$ RI	Energy kWh	Demand kW-mos	Energy \$	Demand \$	Total \$	When	NPV \$	Value Index	
1B	2,571	1,499	0	30	15	180	22,870	(4)	1,127	(23)	1,105	RI	12,255	4.77	
4B	638	372	0	10	15	38	7,805	(5)	388	(25)	383	RI	4,254	6.67	
5B	748	436	0	10	15	48	11,217	(3)	558	(17)	541	RI	6,631	8.87	
6B	857	500	0	10	15	60	16,338	(4)	812	(23)	790	RI	10,020	11.69	
7B	2,571	1,499	0	30	15	180	48,015	(8)	2,437	(45)	2,382	RI	30,379	11.82	

TABLE 2.22. Motor EROs in Grocery (GRO Type) Buildings

Existing motor operating parameters

ID	Existing Equipment			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum	Monthly Peak	Coincident
1	MC-10	Ref. Comp.	10	3,450	82,800	24	980	NA	1,440	4	NA	171,878	NA	257,818	828.8	NA	NA
2	MF-7.5	AHU Fan	7.5	82,800	82,800	1	1,000	NA	1,500	9	NA	5,595	NA	8,383	58.0	NA	NA
3	MF-30	AHU Fan	30	82,800	82,800	1	1,750	NA	750	9	NA	38,185	NA	16,785	225.6	NA	NA

Energy-efficient motor operating parameters

ID	Energy Resource Opportunity			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum	Monthly Peak	Coincident
1A	MCE-10	Ref. Comp.	10	3,450	82,800	24	980	NA	1,440	4	NA	164,968	NA	247,450	792.2	NA	NA
2A	MFE-7.5	AHU Fan	7.5	82,800	82,800	1	1,000	NA	1,500	9	NA	5,335	NA	8,003	58.0	NA	NA
3A	MFE-30	AHU Fan	30	82,800	82,800	1	1,750	NA	750	9	NA	37,870	NA	16,230	216.1	NA	NA

Energy-efficient motor ERO economic parameters

ID	Economic Parameters						First Year Savings					Life Cycle Cost		
	First Cost \$ RI	First Cost \$ ROF	Before O&M \$	After O&M \$	Life Yr	Salvage \$ RI	Energy kWh	Demand kW-mos	Energy \$	Demand \$	Total \$	When	NPV \$	Value Index
1A	12,480	7,275	0	0	15	1,440	17,250	38	858	207	1,065	RI	3,269	0.28
2A	459	268	0	0	15	48	650	3	32	17	49	RI	252	0.55
3A	1,095	638	0	0	15	138	1,850	10	100	52	153	RI	1,119	1.02

2-speed motor operating parameters

ID	Energy Resource Opportunity			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum	Monthly Peak	Coincident
2B	MF-7.5:2.3	AHU Fan	7.5/2.3	82,800	82,800	1	1,000	NA	1,500	9	10	2,791	NA	4,188	62.1	NA	NA
3B	MF-30:7.5	AHU Fan	30/7.5	82,800	82,800	1	1,750	NA	750	9	10	18,441	NA	7,903	237.4	NA	NA

2-speed motor ERO economic parameters

ID	Economic Parameters						First Year Savings					Life Cycle Cost		
	First Cost \$ RI	First Cost \$ ROF	Before O&M \$	After O&M \$	Life Yr	Salvage \$ RI	Energy kWh	Demand kW-mos	Energy \$	Demand \$	Total \$	When	NPV \$	Value Index
2B	748	438	0	10	15	48	7,011	(3)	349	(17)	332	RI	3,687	4.93
3B	1,678	978	0	10	15	138	29,806	(12)	1,803	(65)	1,538	RI	19,879	11.73

**TABLE 2.23. Motor EROs in Medical (MED Type) Buildings:
Existing and Energy-Efficient Motors**

Existing motor operating parameters

Existing Model Operating Parameters																	
ID	Existing Equipment			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum Monthly Peak Coincident	On-Peak	Mid-Peak
1	MP-1	HW Pump	1	9,475	104,227	11	500	NA	750	8	NA	4,103	NA	8,155	64.5	NA	NA
2	MAC-1.5	Air Comp	1.5	3,722	104,227	28	350	NA	150	1	NA	10,968	NA	4,700	40.5	NA	NA
3	MP-3	Vac Pump	3	17,371	104,227	8	350	NA	150	3	NA	4,700	NA	2,014	50.0	NA	NA
4	MP-10	Vac Pump	10	17,371	104,227	8	350	NA	150	3	NA	15,968	NA	6,714	155.8	NA	NA
5	MP-20	Vac Pump	20	9,475	104,227	11	190	NA	285	3	NA	31,183	NA	48,774	559.5	NA	NA
6	MP-25	Wtr Tr Pump	25	6,131	104,227	17	190	NA	285	3	NA	80,240	NA	90,359	1089.9	NA	NA
7	MF-187	Toilet EXH	0.187	6,131	104,227	17	2,000	NA	0	8	NA	4,227	NA	0	22.7	NA	NA
8	MF-10	Booster EXH	10	17,371	104,227	8	700	NA	300	8	NA	31,332	NA	13,428	311.2	NA	NA
9	MF-187	SF1	0.187	52,114	104,227	2	800	NA	900	9	NA	149	NA	224	3.0	NA	NA
10	MF-7.5	SF2	7.5	52,114	104,227	2	800	NA	900	9	NA	8,714	NA	10,071	118.1	NA	NA
11	MF-20	AHU Fan	20	17,371	104,227	8	580	NA	240	9	NA	50,131	NA	21,485	915.5	NA	NA
12	MF-5	Return Fan	5	52,114	104,227	2	500	NA	750	3	NA	3,730	NA	5,585	28.9	NA	NA
13	MP-2	Chill Pump	2	20,845	104,227	5	700	NA	300	3	NA	5,222	NA	2,238	28.5	NA	NA
14	MP-5	Wtr Pmp Co	5	34,742	104,227	3	500	NA	750	8	NA	5,585	NA	8,383	80.7	NA	NA
15	MP-7.5	Supply Pmp	0.75	34,742	104,227	3	400	NA	800	8	NA	871	NA	1,007	13.3	NA	NA
16	MP-3	Supply Pmp	3	34,742	104,227	3	400	NA	800	8	NA	2,688	NA	4,028	50.0	NA	NA
17	MAC-7.5	Air Comp.	7.5	34,742	104,227	3	350	NA	150	3	NA	5,875	NA	2,518	59.0	NA	NA
18	MAC-20	Air Comp.	20	34,742	104,227	3	350	NA	150	3	NA	15,868	NA	6,714	152.8	NA	NA
19	MF-5	AHU Fan	5	52,114	104,227	2	800	NA	900	9	NA	4,478	NA	6,714	80.7	NA	NA
20	MF-7.5	AHU Fan	7.5	52,114	104,227	2	1,050	NA	450	9	NA	11,750	NA	5,036	118.1	NA	NA
21	MP-25	Supply Pmp	0.25	34,742	104,227	3	400	NA	800	8	NA	224	NA	338	4.5	NA	NA

Energy-efficient motor operating parameters

Energy Efficient Motor Operating Parameters																	
ID	Energy Resource Opportunity			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum Monthly Peak Coincident	On-Peak	Mid-Peak
1A	MPE-1	HW Pump	1	9,475	104,227	11	500	NA	750	8	NA	3,751	NA	5,827	58.9	NA	NA
2A	MACE-1.5	Air Comp	1.5	3,722	104,227	28	350	NA	150	1	NA	10,183	NA	4,355	37.3	NA	NA
3A	MPE-3	Vac Pump	3	17,371	104,227	8	350	NA	150	3	NA	4,343	NA	1,881	45.9	NA	NA
4A	MPE-10	Vac Pump	10	17,371	104,227	8	350	NA	150	3	NA	15,038	NA	6,444	148.5	NA	NA
5A	MPE-20	Vac Pump	20	9,475	104,227	11	190	NA	285	3	NA	29,950	NA	44,925	534.8	NA	NA
6A	MPE-25	Wtr Tr Pump	25	6,131	104,227	17	190	NA	285	3	NA	58,011	NA	87,016	1022.7	NA	NA
8A	MFE-10	Booster EXH	10	17,371	104,227	8	700	NA	300	8	NA	30,072	NA	12,888	297.1	NA	NA
10	MFE-7.5	SF2	7.5	52,114	104,227	2	800	NA	900	9	NA	6,402	NA	9,603	112.0	NA	NA
11	MFE-20	AHU Fan	20	17,371	104,227	8	580	NA	240	9	NA	48,148	NA	20,835	874.8	NA	NA
12	MFE-5	Return Fan	5	52,114	104,227	2	500	NA	750	3	NA	3,540	NA	5,310	25.4	NA	NA
13	MPE-2	Chill Pump	2	20,845	104,227	5	700	NA	300	3	NA	4,872	NA	2,088	28.5	NA	NA
14	MPE-5	Wtr Pmp Co	5	34,742	104,227	3	500	NA	750	8	NA	5,310	NA	7,985	78.1	NA	NA
16	MPE-3	Supply Pmp	3	34,742	104,227	3	400	NA	800	8	NA	2,482	NA	3,722	45.9	NA	NA
17	MACE-7.5	Air Comp.	7.5	34,742	104,227	3	350	NA	150	3	NA	5,802	NA	2,401	58.0	NA	NA
18	MACE-20	Air Comp.	20	34,742	104,227	3	350	NA	150	3	NA	15,047	NA	6,448	145.8	NA	NA
19	MFE-5	AHU Fan	5	52,114	104,227	2	800	NA	900	9	NA	4,248	NA	6,372	78.1	NA	NA
20	MFE-7.5	AHU Fan	7.5	52,114	104,227	2	1,050	NA	450	9	NA	11,204	NA	4,802	112.0	NA	NA

Energy-efficient motor ERO economic parameters

ID	Economic Parameters						First Year Savings					Life Cycle Cost		
	First Cost \$ RI	First Cost \$ ROF	Before O&M \$	After O&M \$	Life Yr	Salvage \$ RI	Energy kWh	Demand kW-mos	Energy \$	Demand \$	Total \$	When	NPV \$	Value Index
1A	3,258	1,898	0	0	15	290	880	8	24	17	41	ROF	215	0.11
2A	8,784	5,109	0	0	15	818	1,148	3	34	10	44	ROF	(87)	-0.02
3A	1,898	1,105	0	0	15	173	510	4	15	12	27	ROF	143	0.13
4A	3,120	1,819	0	0	15	380	900	7	27	21	48	ROF	194	0.11
5A	9,548	5,568	0	0	15	1,083	3,082	25	84	75	159	ROF	691	0.12
8A	18,711	9,741	0	0	15	2,008	5,572	47	151	142	294	ROF	1,348	0.14
8A	3,120	1,819	0	0	15	380	1,800	14	53	42	98	ROF	863	0.38
10	918	535	0	0	15	96	780	8	39	34	72	RI	147	0.18
11	5,208	3,036	0	0	15	588	2,832	41	153	224	378	RI	415	0.08
12	726	423	0	0	15	72	475	2	13	5	17	ROF	116	0.28
13	1,850	982	0	0	15	159	500	2	15	8	21	ROF	102	0.11
14	1,089	635	0	0	15	107	713	5	19	14	33	ROF	244	0.38
16	848	553	0	0	15	86	510	4	14	12	28	ROF	194	0.35
17	1,377	803	0	0	15	144	380	3	12	9	21	ROF	85	0.08
18	2,804	1,518	0	0	15	298	884	7	28	20	47	ROF	221	0.15
19	726	423	0	0	15	72	570	5	28	25	54	RI	84	0.12
20	918	535	0	0	15	96	780	8	42	34	76	RI	196	0.21

TABLE 2.24. Motor EROs in Medical (MED Type) Buildings: Two-Speed Motors

2-speed motor operating parameters

ID	Energy Resource Opportunity			Density SqFt/Mtr	Total SqFt	# of Motrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum Monthly Peak	Coincident	
88	MF-10:2.5	Booster EXH	10/2.5	17,371	104,227	6	700	NA	300	6	10	14,177	NA	6,076	327.6	NA	NA
10	MF-7.5:2.3	SF2	7.5/2.3	52,114	104,227	2	800	NA	900	9	10	3,348	NA	5,023	124.3	NA	NA
11	MF-20:5	AHU Fan	20/5	17,371	104,227	6	580	NA	240	9	10	23,213	NA	9,948	963.7	NA	NA
12	MF-5:1.2	Return Fan	5/1.2	52,114	104,227	2	500	NA	750	3	10	1,779	NA	2,668	29.9	NA	NA
13	MP-2:1.5	Chill Pump	2/1.5	20,845	104,227	5	700	NA	300	3	10	2,391	NA	1,025	31.7	NA	NA
14	MP-5:1.2	Wtr Pmp Co	5/1.2	34,742	104,227	3	500	NA	750	6	10	2,668	NA	4,002	89.7	NA	NA
16	MP-3:1.75	Supply Pmp	3/1.75	34,742	104,227	3	400	NA	800	6	10	1,268	NA	1,901	55.5	NA	NA
19	MF-5:1.2	AHU Fan	5/1.2	52,114	104,227	2	800	NA	900	9	10	2,135	NA	3,202	89.7	NA	NA
20	MF-7.5:2.3	AHU Fan	7.5/2.3	52,114	104,227	2	1,050	NA	450	9	10	5,861	NA	2,512	124.3	NA	NA

2-speed motor ERO economic parameters

ID	Economic Parameters						First Year Savings					Life Cycle Cost		
	First Cost \$ RI	First Cost \$ ROF	Before O&M \$	After O&M \$	Life Yr	Salvage \$ RI	Energy kWh	Demand kW-mos	Energy \$	Demand \$	Total \$	When	NPV \$	Value Index
88	5,142	2,997	0	60	15	360	24,507	(18)	1,327	(90)	1,237	RI	10,819	2.10
10	1,497	873	0	20	15	98	8,413	(8)	418	(34)	384	RI	3,448	2.30
11	7,899	4,605	0	60	15	596	38,455	(48)	2,063	(266)	1,817	RI	16,085	2.04
12	1,276	744	0	20	15	72	4,878	(3)	243	(17)	226	RI	1,480	1.14
13	2,928	1,707	0	50	15	159	4,044	(3)	120	(10)	110	ROF	26	0.02
14	1,914	1,116	0	30	15	107	7,318	(9)	364	(50)	314	RI	1,841	0.98
16	1,712	998	0	30	15	88	3,545	(6)	98	(17)	80	ROF	150	0.15
19	1,276	744	0	20	15	72	5,853	(9)	291	(50)	241	RI	1,877	1.31
20	1,497	873	0	20	15	98	8,413	(8)	458	(34)	421	RI	3,971	2.85

TABLE 2.25. Motor EROs in Mess Hall (MES Type) Buildings

Existing motor operating parameters

ID	Existing Equipment			Density SqFt/Mtr	Total SqFt	# of Motrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum Monthly	Peak	Coincident
1	MF-3	AHU-1	0.5	12,481	87,367	7	1,750	NA	750	9	NA	4,569	NA	1,958	31.2	NA	NA
2	MF-5:2.2	AHU-2	5-2.2	12,481	87,367	7	1,000	NA	1,500	9	25	15,144	NA	22,715	282.4	NA	NA
3	MF-5:2.2	AHU-2	5-2.2	12,481	87,367	7	800	NA	1,200	9	10	10,380	NA	15,541	282.4	NA	NA
4	MF-3:75	AHU-3	3-75	12,481	87,367	7	1,000	NA	1,500	9	10	5,091	NA	7,837	174.9	NA	NA
5	MF-3:75	AHU-3	3-75	12,481	87,367	7	1,000	NA	1,500	9	10	5,091	NA	7,837	174.9	NA	NA
6	MF-10:2.5	AHU-4	10-2.5	12,481	87,367	7	1,000	NA	1,500	9	10	16,971	NA	25,457	544.8	NA	NA
7	MF-10:2.5	AHU-4	10-2.5	12,481	87,367	7	800	NA	1,200	9	10	13,577	NA	20,366	544.8	NA	NA
8	MF-7.5:2.3	AHU-5	7.5-2.3	12,481	87,367	7	1,200	NA	1,800	9	10	17,871	NA	26,507	413.2	NA	NA
9	MF-7.5:2.3	AHU-5	7.5-2.3	12,481	87,367	7	1,200	NA	1,800	9	10	17,871	NA	26,507	413.2	NA	NA
10	MF-3	AHU-6	0.5	12,481	87,367	7	1,200	NA	1,800	9	NA	3,133	NA	4,700	31.2	NA	NA
11	MF-3	Toilet EXH	0.5	8,241	87,367	14	2,080	NA	0	12	NA	10,882	NA	0	83.3	NA	NA
12	MF-1:25	Equip. room	1-25	12,481	87,367	7	784	NA	328	3	10	1,297	NA	556	20.5	NA	NA
13	MF-5:2.2	Atmc Vent	5-2.2	8,241	87,367	14	800	NA	1,200	3	33	26,172	NA	39,257	188.3	NA	NA
14	MF-5:2.2	Gen. Vent	5-2.2	12,481	87,367	7	1,750	NA	750	9	25	26,502	NA	11,358	282.4	NA	NA
15	MF-3:75	Gen. Vent	3-75	12,481	87,367	7	1,750	NA	750	9	25	11,995	NA	5,141	174.9	NA	NA
16	MF-3:75	Dish Wash Fa	3-75	8,241	87,367	14	800	NA	1,200	8	25	10,968	NA	16,450	311.0	NA	NA
17	MF-33	Storage Fan	0.33	8,241	87,367	14	1,200	NA	1,800	8	NA	4,136	NA	6,204	27.9	NA	NA
18	MP-1.5	Ref Comp	1.5	4,160	87,367	21	800	NA	1,200	3	NA	18,799	NA	28,199	91.1	NA	NA
19	MP-1	Pump	1	12,481	87,367	7	800	NA	1,200	3	NA	4,178	NA	8,266	20.5	NA	NA
20	MAC-5	AC Comp.	0.5	12,481	87,367	7	900	NA	0	3	NA	2,350	NA	0	10.4	NA	NA
21	MAC-1	AC Comp.	1	8,241	87,367	14	900	NA	0	3	NA	9,400	NA	0	41.1	NA	NA

Energy-efficient motor operating parameters

ID	Energy Resource Opportunity			Density SqFt/Mtr	Total SqFt	# of Motrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum Monthly	Peak	Coincident
18A	MPE-1.5	Ref Comp	1.5	4,160	87,367	21	800	NA	1,200	3	NA	17,422	NA	26,132	83.8	NA	NA
19A	MPE-1	Pump	1	12,481	87,367	7	800	NA	1,200	3	NA	3,819	NA	5,729	18.7	NA	NA
21A	MACE-1	AC Comp.	1	8,241	87,367	14	900	NA	0	3	NA	8,583	NA	0	37.5	NA	NA

Energy-efficient motor ERO economic parameters

ID	Economic Parameters						First Year Savings					Life Cycle Cost		
	First Cost \$ RI	First Cost \$ ROF	Before O&M \$	After O&M \$	Life Yr	Salvage \$ RI	Energy kWh	Demand kW-mos	Energy \$	Demand \$	Total \$	When	NPV \$	Value Index
18A	6,573	3,832	0	0	15	813	3,444	7	94	22	116	ROF	749	0.20
19A	2,072	1,208	0	0	15	185	898	2	24	5	30	ROF	175	0.14
21A	4,144	2,416	0	0	15	370	807	4	26	11	37	ROF	125	0.05

2-speed motor operating parameters

The 2-speed ERO is not applicable to these MES buildings

TABLE 2.26. Motor EROs in Recreational (REC Type) Buildings

Existing motor operating parameters

ID	Existing Equipment			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum Monthly Peak Coincident	On-Peak	Mid-Peak
1	MAC-3	Air Comp	0.5	31,492	251,935	8	700	NA	300	1	NA	2,089	NA	895	4.0	NA	NA
2	MF-3	Return Fan	3	31,492	251,935	8	1,000	NA	1,500	3	NA	17,904	NA	28,856	98.8	NA	NA
3	MF-5	Return Fan	5	31,492	251,935	8	1,000	NA	1,500	3	NA	29,840	NA	44,780	107.6	NA	NA
4	MF-7.5	AHU Fan	7.5	31,492	251,935	8	1,100	NA	1,650	9	NA	49,236	NA	73,854	472.3	NA	NA
5	MF-10	AHU Fan	10	31,492	251,935	8	1,100	NA	1,650	9	NA	65,848	NA	98,472	622.4	NA	NA
6	MP-5	HTHW Pum	5	15,748	251,935	16	1,200	NA	1,800	6	NA	71,616	NA	107,424	430.4	NA	NA
7	MF-3	EXH Fan	3	10,954	251,935	23	2,000	NA	0	9	NA	102,948	NA	0	574.8	NA	NA
8	MF-3	Supply Fan	3	31,492	251,935	8	1,000	NA	1,500	9	NA	17,904	NA	28,856	199.9	NA	NA

Energy-efficient motor operating parameters

ID	Energy Resource Opportunity			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum Monthly Peak Coincident	On-Peak	Mid-Peak
2A	MFE-3	Return Fan	3	31,492	251,935	8	1,000	NA	1,500	3	NA	16,544	NA	24,816	81.2	NA	NA
3A	MFE-5	Return Fan	5	31,492	251,935	8	1,000	NA	1,500	3	NA	26,320	NA	42,480	101.5	NA	NA
4A	MFE-7.5	AHU Fan	7.5	31,492	251,935	8	1,100	NA	1,650	9	NA	46,948	NA	70,422	448.1	NA	NA
5A	MFE-10	AHU Fan	10	31,492	251,935	8	1,100	NA	1,650	9	NA	63,008	NA	94,512	594.2	NA	NA
6A	MPE-5	HTHW Pum	5	15,748	251,935	16	1,200	NA	1,800	6	NA	87,968	NA	101,952	408.0	NA	NA
7A	MFE-3	EXH Fan	3	10,954	251,935	23	2,000	NA	0	9	NA	95,128	NA	0	527.8	NA	NA
8A	MFE-3	Supply Fan	3	31,492	251,935	8	1,000	NA	1,500	9	NA	16,544	NA	24,816	183.5	NA	NA

Energy-efficient motor ERO economic parameters

ID	Economic Parameters						First Year Savings					Life Cycle Cost			
	First Cost \$ RI	First Cost \$ ROF	Before O&M \$	After O&M \$	Life Yr	Salvage \$ RI	Energy kWh	Demand kW-mos	Energy \$	Demand \$	Total \$	When	NPV \$	Value Index	
2A	2,528	1,474	0	0	15	230	3,400	5	189	30	199	RI	482	0.19	
3A	2,904	1,693	0	0	15	286	3,800	8	189	34	223	RI	446	0.15	
4A	3,672	2,141	0	0	15	384	5,720	24	284	133	418	RI	2,394	0.85	
5A	4,160	2,425	0	0	15	480	6,600	28	328	155	484	RI	2,901	0.70	
6A	5,808	3,386	0	0	15	573	9,120	24	454	134	588	RI	2,902	0.50	
7A	7,268	4,237	0	0	15	882	7,820	47	458	280	718	RI	3,449	0.47	
8A	2,528	1,474	0	0	15	230	3,400	16	189	90	259	RI	1,335	0.53	

2-speed motor operating parameters

Energy Resource Opportunity				Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
ID	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum Monthly Peak Coincident	On-Peak	Mid-Peak
2B	MF-3:1.75	Return Fan	3/1.75	31,492	251,935	8	1,000	NA	1,500	3	10	8,450	NA	12,675	74.0	NA	NA
3B	MF-5:1.2	Return Fan	5/1.2	31,492	251,935	8	1,000	NA	1,500	3	10	14,230	NA	21,345	119.8	NA	NA
4B	MF-7.5:2.3	AHU Fan	7.5/2.3	31,492	251,935	8	1,100	NA	1,650	9	10	24,559	NA	36,838	497.1	NA	NA
5B	MF-10:2.5	AHU Fan	10/2.5	31,492	251,935	8	1,100	NA	1,650	9	10	29,703	NA	44,555	655.1	NA	NA
6B	MP-5:1.2	HTHW Pum	5/1.2	15,748	251,935	16	1,200	NA	1,800	6	10	34,152	NA	51,228	478.2	NA	NA
7B	MF-3:1.75	EXH Fan	3/1.75	10,954	251,935	23	2,000	NA	0	9	10	48,588	NA	0	638.8	NA	NA
8B	MF-3:1.75	Supply Fan	3/1.75	31,492	251,935	8	1,000	NA	1,500	9	10	8,450	NA	12,675	222.1	NA	NA

2-speed motor ERO economic parameters

ID	Economic Parameters						First Year Savings					Life Cycle Cost			
	First Cost \$ RI	First Cost \$ ROF	Before O&M \$	After O&M \$	Life Yr	Salvage \$ RI	Energy kWh	Demand kW-mos	Energy \$	Demand \$	Total \$	When	NPV \$	Value Index	
2B	4,584	2,661	0	80	15	230	23,835	(7)	1,175	(41)	1,135	RI	9,678	2.12	
3B	5,104	2,975	0	80	15	286	39,025	(12)	1,941	(66)	1,875	RI	19,499	3.82	
4B	5,988	3,489	0	80	15	384	61,683	(25)	3,068	(137)	2,931	RI	33,417	5.58	
5B	8,856	3,997	0	80	15	480	89,862	(33)	4,489	(180)	4,288	RI	51,578	7.52	
6B	10,208	5,951	0	160	15	573	93,660	(48)	4,658	(263)	4,394	RI	48,079	4.71	
7B	13,122	7,649	0	230	15	662	54,360	(64)	3,185	(352)	2,833	RI	21,793	1.66	
8B	4,584	2,661	0	80	15	230	23,835	(22)	1,175	(122)	1,053	RI	8,530	1.87	

TABLE 2.27. Motor EROs in Vehicle Maintenance Shops (SHP Type) Buildings

Existing motor operating parameters

ID	Existing Equipment			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum	Monthly Peak	Coincident
1	MP-2	HW Pump	2	8,848	485,713	88	1,400	NA	2,100	8	NA	142,038	NA	213,058	775.5	NA	NA
2	MAC-5	Air Comp.	0.5	42,338	485,713	11	1,019	NA	437	1	NA	4,182	NA	1,782	5.5	NA	NA
3	MAC-15	Air Comp.	15	42,338	485,713	11	580	NA	240	4	NA	68,830	NA	28,342	364.8	NA	NA
4	MF-2	Exh Fans	2	7,277	485,713	84	1,500	NA	0	8	NA	143,232	NA	0	973.1	NA	NA
5	MF-3	SMF Fans	3	22,177	485,713	21	700	NA	1,050	9	NA	32,898	NA	48,348	524.8	NA	NA
6	MF-9	Exh Fans	5	4,352	485,713	107	1,500	NA	0	8	NA	588,685	NA	0	3,837.8	NA	NA
7	MP-7.5	MP HHCBN	7.5	42,338	485,713	11	800	NA	900	8	NA	38,627	NA	55,381	577.2	NA	NA
8	MF-10	SMF Fan	10	22,177	485,713	21	700	NA	1,050	9	NA	109,682	NA	184,493	1,089.2	NA	NA
9	MF-9	MAHU	5	14,554	485,713	32	1,050	NA	450	9	NA	123,328	NA	53,712	1,291.2	NA	NA
10	MF-10	MAHU	10	14,554	485,713	32	1,050	NA	450	9	NA	250,658	NA	107,424	2,489.5	NA	NA
11	MF-15	MAHU	15	42,338	485,713	11	1,050	NA	450	9	NA	129,244	NA	55,381	1,270.4	NA	NA

Energy-efficient motor operating parameters

ID	Energy Resource Opportunity			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum	Monthly Peak	Coincident
1A	MPE-2	HW Pump	2	8,848	485,713	88	1,400	NA	2,100	8	NA	132,518	NA	198,778	719.5	NA	NA
3A	MACE-15	Air Comp.	15	42,338	485,713	11	580	NA	240	4	NA	68,035	NA	28,301	536.3	NA	NA
4A	MFE-2	Exh Fans	2	7,277	485,713	84	1,500	NA	0	8	NA	133,832	NA	0	903.0	NA	NA
5A	MFE-3	SMF Fans	3	22,177	485,713	21	700	NA	1,050	9	NA	30,400	NA	45,598	481.8	NA	NA
6A	MFE-5	Exh Fans	5	4,352	485,713	107	1,500	NA	0	8	NA	588,170	NA	0	3,820.0	NA	NA
7A	MPE-7.5	MP HHCBN	7.5	42,338	485,713	11	800	NA	900	8	NA	35,211	NA	52,817	547.7	NA	NA
8A	MFE-10	SMF Fan	10	22,177	485,713	21	700	NA	1,050	9	NA	105,252	NA	157,878	1,039.8	NA	NA
9A	MFE-5	MAHU	5	14,554	485,713	32	1,050	NA	450	9	NA	118,944	NA	50,978	1,218.0	NA	NA
10A	MFE-10	MAHU	10	14,554	485,713	32	1,050	NA	450	9	NA	240,578	NA	103,104	2,378.8	NA	NA
11A	MFE-15	MAHU	15	42,338	485,713	11	1,050	NA	450	9	NA	123,818	NA	53,084	1,213.4	NA	NA

Energy-efficient motor ERO economic parameters

ID	Economic Parameters					First Year Savings					Life Cycle Cost			
	First Cost \$ RI	First Cost \$ ROF	Before O&M \$	After O&M \$	Life Yr	Salvage \$ RI	Energy kWh	Demand kW-mos	Energy \$	Demand \$	Total \$	When	NPV \$	Value Index
1A	22,440	13,081	0	0	15	2,162	23,800	58	1,184	309	1,492	RI	534	0.02
3A	8,228	4,798	0	0	15	873	4,138	25	122	78	199	ROF	1,199	0.25
4A	21,120	12,312	0	0	15	2,035	9,800	70	307	211	518	ROF	3,780	0.31
5A	8,836	3,868	0	0	15	605	6,248	43	311	237	548	RI	1,826	0.25
6A	39,841	22,642	0	0	15	3,831	30,495	218	1,787	1,199	2,986	RI	8,086	0.18
7A	5,049	2,943	0	0	15	528	4,290	30	213	163	376	RI	498	0.10
8A	10,920	6,366	0	0	15	1,280	11,025	49	548	272	820	RI	1,295	0.12
9A	11,818	6,771	0	0	15	1,148	9,120	72	494	389	883	RI	1,819	0.18
10A	18,840	9,700	0	0	15	1,920	14,400	113	780	622	1,402	RI	4,110	0.25
11A	8,228	4,798	0	0	15	873	7,758	57	420	314	734	RI	2,588	0.31

2-speed motor operating parameters

ID	Energy Resource Opportunity			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum	Monthly Peak	Coincident
4B	MF-2:5	Exh Fans	2/5	7,277	485,713	84	1,500	NA	0	8	10	65,577	NA	0	1,081.3	NA	NA
5B	MF-3:7.5	SMF Fans	3/7.5	22,177	485,713	21	700	NA	1,050	9	10	15,527	NA	23,291	583.1	NA	NA
6B	MF-5:1.2	Exh Fans	5/1.2	4,352	485,713	107	1,500	NA	0	8	10	285,480	NA	0	4,264.0	NA	NA
7B	MP-7.5:2.3	MP HHCBN	7.5/2.3	42,338	485,713	11	800	NA	900	8	10	18,419	NA	27,829	607.8	NA	NA
8B	MF-10:2.5	SMF Fan	10/2.5	22,177	485,713	21	700	NA	1,050	9	10	49,618	NA	74,427	1,148.5	NA	NA
9B	MF-5:1.2	MAHU	5/1.2	14,554	485,713	32	1,050	NA	450	9	10	59,768	NA	25,614	1,434.8	NA	NA
10B	MF-10:2.5	MAHU	10/2.5	14,554	485,713	32	1,050	NA	450	9	10	113,413	NA	48,808	2,820.8	NA	NA
11B	MF-15:3.75	MAHU	15/3.75	42,338	485,713	11	1,050	NA	450	9	10	58,208	NA	25,375	1,337.3	NA	NA

2-speed motor ERO economic parameters

2-speed motor LDC economic parameters														
ID	Economic Parameters					First Year Savings					Life Cycle Cost			
	First Cost \$ RI	First Cost \$ ROF	Before O&M \$	After O&M \$	Life Yr	Salvage \$ RI	Energy kWh	Demand kW-mos	Energy \$	Demand \$	Total \$	When	NPV \$	Value Index
4B	37,472	21,844	0	640	15	2,035	77,855	(108)	4,550	(586)	3,954	RI	4,485	0.12
5B	11,981	8,984	0	210	15	605	43,429	(58)	2,180	(321)	1,838	RI	9,380	0.78
6B	68,268	39,795	0	1,070	15	3,831	313,175	(426)	18,348	(2,349)	15,999	RI	133,087	1.95
7B	8,231	4,798	0	110	15	528	48,270	(30)	2,301	(168)	2,133	RI	19,244	2.34
8B	17,997	10,481	0	210	15	1,280	150,110	(57)	7,465	(316)	7,149	RI	77,581	4.31
9B	20,418	11,901	0	320	15	1,148	93,680	(143)	5,073	(790)	4,282	RI	32,728	1.80
10B	27,424	15,986	0	320	15	1,920	198,081	(131)	10,818	(722)	9,896	RI	104,148	3.80
11B	12,419	7,239	0	110	15	873	100,052	(67)	5,419	(389)	5,050	RI	55,982	4.51

TABLE 2.28. Motor EROs in SMA (SMA Type) Buildings

Existing motor operating parameters

Existing Motor Operating Parameters																	
ID	Existing Equipment			Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum Monthly Peak Coincident	On-Peak	Mid-Peak
1	MP-2	HW Pump	2	7,191	208,532	29	1,400	NA	2,100	8	NA	80,575	NA	80,863	330.7	NA	NA
2	MAC-3	Air Comp.	0.5	41,708	208,532	5	1,019	NA	437	1	NA	1,901	NA	815	2.5	NA	NA
3	MAC-15	Air Comp.	15	41,708	208,532	5	525	NA	225	4	NA	29,374	NA	12,589	258.7	NA	NA
4	MF-2	Exh Fans	2	7,723	208,532	27	1,500	NA	0	8	NA	80,428	NA	0	410.5	NA	NA
5	MF-3	SMF Fans	3	23,170	208,532	9	700	NA	1,050	9	NA	14,068	NA	21,149	224.9	NA	NA
6	MF-5	Exh Fans	5	4,834	208,532	45	1,500	NA	0	8	NA	251,775	NA	0	1613.9	NA	NA
7	MP-7.5	MP HHCBN	7.5	41,708	208,532	5	800	NA	900	8	NA	16,785	NA	25,178	262.4	NA	NA
8	MF-10	SMF Fan	10	23,170	208,532	9	700	NA	1,050	8	NA	48,998	NA	70,497	488.8	NA	NA
9	MF-5	MAHU	5	18,041	208,532	13	1,050	NA	450	9	NA	50,915	NA	21,821	524.5	NA	NA
10	MF-10	MAHU	10	18,041	208,532	13	1,050	NA	450	9	NA	101,829	NA	43,641	1011.4	NA	NA
11	MF-15	MAHU	15	41,708	208,532	5	1,050	NA	450	9	NA	58,747	NA	25,178	577.5	NA	NA

Energy-efficient motor operating parameters

Energy Resource Opportunity				Density SqFt/Mtr	Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
ID	Equip Code	Type of Motor	Rating HP				Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum Monthly Peak Coincident	On-Peak	Mid-Peak
1A	MPE-2	HW Pump	2	7,191	208,532	29	1,400	NA	2,100	8	NA	58,515	NA	84,773	308.9	NA	NA
3A	MACE-15	Air Comp.	15	41,708	208,532	5	525	NA	225	4	NA	28,140	NA	12,080	245.1	NA	NA
4A	MFE-2	Exh Fans	2	7,723	208,532	27	1,500	NA	0	8	NA	58,378	NA	0	380.9	NA	NA
5A	MFE-3	SMF Fans	3	23,170	208,532	9	700	NA	1,050	9	NA	13,028	NA	19,543	208.5	NA	NA
6A	MFE-5	Exh Fans	5	4,834	208,532	45	1,500	NA	0	8	NA	238,950	NA	0	1522.4	NA	NA
7A	MPE-7.5	MP HHCBN	7.5	41,708	208,532	5	600	NA	900	8	NA	18,005	NA	24,008	248.9	NA	NA
8A	MFE-10	SMF Fan	10	23,170	208,532	9	700	NA	1,050	8	NA	45,108	NA	87,862	445.6	NA	NA
9A	MFE-5	MAHU	5	18,041	208,532	13	1,050	NA	450	9	NA	48,321	NA	20,709	484.8	NA	NA
10A	MFE-10	MAHU	10	18,041	208,532	13	1,050	NA	450	9	NA	97,734	NA	41,888	985.5	NA	NA
11A	MFE-15	MAHU	15	41,708	208,532	5	1,050	NA	450	9	NA	58,280	NA	24,120	551.5	NA	NA

Energy-efficient motor ERO economic parameters

ID	Economic Parameters						First Year Savings					Life Cycle Cost			
	First Cost \$ RI	First Cost \$ ROF	Before O&M \$	After O&M \$	Life Yr	Salvage \$ RI	Energy kWh	Demand kW-mos	Energy \$	Demand \$	Total \$	When	NPV \$	Value Index	
1A	9,570	5,579	0	0	15	922	10,150	24	505	131	838	RI	221	0.02	
3A	3,740	2,180	0	0	15	397	1,783	12	52	35	87	ROF	514	0.24	
4A	8,910	5,194	0	0	15	858	4,050	30	130	89	219	ROF	1,598	0.31	
5A	2,844	1,858	0	0	15	258	2,677	18	133	101	235	RI	684	0.24	
6A	18,335	9,522	0	0	15	1,811	12,825	92	751	504	1,256	RI	2,589	0.18	
7A	2,295	1,338	0	0	15	240	1,950	13	97	74	171	RI	233	0.10	
8A	4,880	2,728	0	0	15	540	4,725	21	235	117	352	RI	557	0.12	
9A	4,719	2,751	0	0	15	465	3,708	30	201	164	364	RI	782	0.16	
10A	8,780	3,941	0	0	15	780	5,850	48	317	253	570	RI	1,872	0.25	
11A	3,740	2,180	0	0	15	397	3,528	28	191	143	334	RI	1,184	0.32	

2-speed motor operating parameters

2-Speed Motor Operating Parameters																	
ID	Energy Resource Opportunity				Total SqFt	# of Mtrs	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Energy Demand (kW)		
	Equip Code	Type of Motor	Rating HP	Density SqFt/Mtr			Hrs ON	Hrs MID	Hrs OFF			kWh On-Peak	kWh Mid-Peak	kWh Off-Peak	Sum Monthly Peak Coincident	On-Peak	Mid-Peak
4B	MF-2:5	Exh Fans	2/5	7,723	208,532	27	1,500	NA	0	8	10	27,685	NA	0	458.2	NA	NA
5B	MF-3:7.5	SMF Fans	3/7.5	23,170	208,532	9	700	NA	1,050	9	10	6,654	NA	9,982	249.9	NA	NA
6B	MF-5:1.2	Exh Fans	5/1.2	4,834	208,532	45	1,500	NA	0	8	10	120,068	NA	0	1793.3	NA	NA
7B	MP-7.5:2.3	MP HHCBN	7.5/2.3	41,708	208,532	5	800	NA	900	8	10	8,372	NA	12,559	276.2	NA	NA
8B	MF-10:2.5	SMF Fan	10/2.5	23,170	208,532	9	700	NA	1,050	8	10	21,265	NA	31,897	491.4	NA	NA
9B	MF-5:1.2	MAHU	5/1.2	18,041	208,532	13	1,050	NA	450	9	10	24,280	NA	10,408	582.8	NA	NA
10B	MF-10:2.5	MAHU	10/2.5	18,041	208,532	13	1,050	NA	450	9	10	48,074	NA	19,748	1084.6	NA	NA
11B	MF-15:3.75	MAHU	15/3.75	41,708	208,532	5	1,050	NA	450	9	10	28,913	NA	11,534	607.9	NA	NA

2-speed motor ERO economic parameters

ID	Economic Parameters						First Year Savings					Life Cycle Cost			
	First Cost \$ RI	First Cost \$ ROF	Before O&M \$	After O&M \$	Life Yr	Salvage \$ RI	Energy kWh	Demand kW-mos	Energy \$	Demand \$	Total \$	When	NPV \$	Value Index	
4B	15,809	9,218	0	270	15	858	32,781	(46)	1,919	(252)	1,668	RI	1,882	0.12	
5B	5,135	2,993	0	90	15	259	18,812	(25)	926	(136)	788	RI	4,009	0.78	
6B	28,710	16,736	0	450	15	1,811	131,709	(179)	7,717	(988)	6,728	RI	55,976	1.95	
7B	3,741	2,181	0	50	15	240	21,032	(14)	1,048	(76)	970	RI	8,749	2.34	
8B	7,713	4,498	0	90	15	540	64,333	(25)	3,199	(136)	3,064	RI	33,237	4.31	
9B	8,294	4,835	0	130	15	465	38,050	(58)	2,081	(321)	1,740	RI	13,293	1.80	
10B	11,141	6,484	0	130	15	780	78,850	(53)	4,314	(293)	4,021	RI	42,314	3.80	
11B	5,645	3,291	0	50	15	397	45,478	(30)	2,483	(168)	2,296	RI	25,438	4.51	

2.10 SEWAGE LIFT STATION MOTOR EROs

All sewage lift station motors are included in this analysis except for the North Entry (P-11000) lift station. All of the lift stations have at least two motors for redundancy. One motor (switch selectable) acts as the lead motor. The lead motor comes on when the tank reaches the first high setpoint. The backup motor comes on if the level continues to rise to the second setpoint. The backup pumps are not intended to provide additional capacity, but will serve to do so if the flow into a station exceeds the capacity of the lead pump. The monthly motor run times indicate that the second set point is rarely, if ever, reached at any lift station except for the Old Post treatment plant station. It is common practice to switch the lead pump every few months to equalize wear on the units and to keep them both "limber."

This analysis, however, looked at replacing the lead motor only. The retrofit pump will become the permanent lead pump and the backup pump will be kept limber by running it manually for a few minutes every month during routine maintenance rounds. The first option analyzed was replacing existing motors with high-efficiency models. The second option was replacing the existing motors with two-speed models where applicable. The final option analyzed was downsizing one of the motors. Since the same amount of sewage has to be moved, downsizing will increase run time, but a smaller lead motor will use less energy due to 1) reduced pipe friction loss and 2) motor losses being a smaller fraction of motor output at full-load operation. These effects result in a net savings. All of the forementioned options were evaluated on both a replace immediately (RI) and a replace on failure (ROF) schedule.

Groundwater reportedly leaks into the system in significant volumes along one section of pipe. Evaluating the feasibility of repairing the pipe and assessment of the resulting energy savings was not within the scope of this project. Such an evaluation should be conducted as soon as possible because it is costly to pump the extraneous groundwater.

2.10.1 Energy-Efficient Motor Retrofit

Description

The energy-efficient motor retrofit involves replacing one of the existing motors in a lift station with an energy-efficient motor. The percent efficiency improvement over a new standard motor is a (decreasing) function of motor size. The improvement is about 5% for a 5-hp motor and 4% for a 25-hp motor. The motor loads were determined during a site visit by manually turning each pump on and measuring current and voltage supplied to the motor. Typically, kW was taken to be the rated kW times measured amps/rated amps. Cumulative hours of lead and backup pump operation were obtained from log books maintained by the site operator. Annual kWh was inferred from measured kW and the logged hours.

Assumptions

The performance analysis is based on the following data and technical assumptions specific to this ERO:

- Nine-months worth of operation logs were available (2/91 to 10/91). The average annual kWh is therefore based on the average kW for only those nine months.
- The distribution of the percent time on-peak and off-peak for the lift station motors is assumed to be identical to Fort Drum's on-post electrical energy use breakdown as a whole.

The economic analysis is based on the following cost data and assumptions:

- The maintenance cost difference between standard and energy-efficient motors is negligible.
- The salvage value of a motor is 20% of the cost of a new, standard-efficiency, single-speed motor.
- Standard- and energy-efficient motor costs are from Table A-1 of ACEEE (1991).
- The labor costs associated with immediate replacement are as follows: \$132 for motors of 10 hp and less, \$221 for 15 to 30 hp motors, \$363 for 40 to 75 hp motors, \$856 for motors over 75 hp.

- The motor service life is 15 years except for the Old Post main lift station. Due to the high percentage of run time (over 8200 hours annually), its service life is 5 years.

Results

Quantitative results, presented in Table 2.29 (p. 2.144), are discussed below.

Budget Implications. The energy-efficient motor ERO is cost-effective for lift pump 1. The first cost for Replace Immediately retrofit is \$1,370.

Energy, Demand, and Cost Savings. The electric energy savings for lift station 1 are estimated to be 4,200 kWh per year at a cost savings of \$214 per year. Demand savings are estimated to be 7 kW-months per year with a cost savings of \$39 per year.

Energy Security. This ERO has no direct impact on energy security.

Operations and Maintenance. There will be no significant additional maintenance requirement. Backup pump failures will generally occur less frequently, while lead pump failures will occur correspondingly more frequently.

Environmental Issues. This ERO has no direct environmental impact.

2.10.2 Down-Sized Energy-Efficient Motor Retrofit

Description

In lift stations whose pumps operate only a few hours per month, it is possible to reduce energy consumption by replacing the lead pump with a smaller pump and a smaller, energy-efficient motor. The Po Valley and North Entry Lift Stations were judged to be good candidates for this retrofit in the preliminary ERO screening process. However, there were insufficient data to analyze the application of this ERO to the North Entry Station.

To correctly engineer the retrofit, the flow-head characteristic of the discharge line should be estimated from the characteristic of the existing pump and the measured pressure and pump motor current or power. The correct characteristic for the down-sized pump can then be determined. A reasonable preliminary estimate of savings and cost effectiveness can be made by assuming a typical flow-head characteristic.

Assumptions

The performance analysis is based on the following data and technical assumptions specific to this ERO:

- Nine-months worth of operation logs were available (2/91 to 10/91). The average annual kWh is therefore based on the average kW for the nine available months.
- The distribution of the percent time on-peak and off-peak for the lift station motors is considered to be identical to the base energy use breakdown as a whole.
- The head developed by the existing pump is due half to turbulent pipe friction loss and half to static head.

The economic analysis is based on the following cost data and assumptions:

- The maintenance cost difference between standard and high efficiency is negligible.
- The salvage value of a motor is considered to be 20% of the cost of a new motor (standard single-speed).
- The cost of a 10-hp motor and pump is \$2,200 (Means 1991).
- The labor to install the pump is \$400 (Means 1991).
- The life of a new motor is 8 years. This is shorter than in other applications because the down-sized motor runs about 5,000 hours/year.
- The replace-on-failure (ROF) option is based on the \$2,200 cost of a 10-hp motor and pump less the cost of a new standard-efficiency 90-hp motor.
- The labor cost difference for the ROF option is negligible due to the cost of the smaller motor and pump being offset by the cost of piping modifications needed to install the smaller pump.

Results

Quantitative results of the ERO analysis are presented in Table 2.30 (p. 2.145). The results are discussed below.

Budget Implications. The first cost of the downsized energy-efficient motor retrofit is \$867.

Energy, Demand, and Cost Savings. The electric energy savings associated with all cost-effective implementations of this ERO are estimated to be 34,000 kWh per year at a cost savings of \$1,700 per year. Demand savings are estimated to be 65 kW per year with a cost savings of \$360 per year. These savings represent over 50% of the current cost of energy to operate the Po Valley Lift Station.

Energy Security. This ERO has no direct impact on energy security.

Operations and Maintenance. There will be no significant additional maintenance requirement, and it is likely that the average maintenance cost will be lower with the downsized pump. Backup pump failures will generally occur less frequently while lead pump failures will occur more frequently. The lead pump repair or replacement cost will be much lower because of its smaller size.

Environmental Issues. This ERO has no direct environmental impact.

2.10.3 Two-Speed Motor Retrofit

Description

The two-speed motor retrofit involves replacing the existing motor with a two-speed motor and adding a level switch to the existing 3- or 4-level control system.

Assumptions

The performance analysis is based on the following data and technical assumptions specific to this ERO:

- Nine-months of operation logs were available (2/91 to 10/91). The average annual kWh is therefore based on the average kW for the nine available months.
- The distribution of the percent time on-peak and off-peak for the sewage lift station motors is considered to be identical to the base energy use breakdown as a whole.
- Two-speed motor operation is at high speed 10% and at low speed 90% of its total operating time.
- The head developed by the existing pump is due half to turbulent pipe friction loss and half to static head.

The economic analysis is based on the following cost data and assumptions:

- The maintenance cost difference between standard and high efficiency is negligible. However, a small increase in maintenance costs is included for the standard to two-speed retrofit (\$10/yr per motor) to cover maintenance of an additional control circuit.
- The salvage value of a motor is 20% the cost of a new, standard-efficiency, single-speed motor.
- The installed cost of a two-speed motor controller is \$100. The cost of a two-speed motor is \$200 plus \$15 per horsepower.
- The labor costs associated with replacing immediately are as follows: \$132 for motors of 10 hp and less, \$221 for 15- to 30-hp motors, \$363 for 40- to 75-hp motors, \$856 for motors over 75 hp.
- The service life of a pump motor is 15 years.

Results

Quantitative results of the ERO analysis are presented in Table 2.30. The results are discussed below.

Budget Implications. The first cost of all cost-effective two-speed lift station motor retrofits is \$8,952. The ROF cost represents the difference between two-speed and single-speed replacement motor cost plus the cost of two-speed controls and their installation.

Energy, Demand, and Cost Savings. The electric energy savings associated with all cost-effective implementations of this ERO are estimated to be 32,898 kWh per year at a cost savings of \$1,462 per year. Demand savings are very small, amounting to about 17 kW per year with a cost savings of \$91 per year.

Energy Security. This ERO has no direct impact on energy security.

Operation and Maintenance. There will be, on the average, slightly more maintenance associated with the additional control circuit elements. Backup

pump failures will generally occur less frequently while lead pump failures will occur correspondingly more frequently, resulting in a negligible increase in motor maintenance.

Environmental Issues. This ERO has no direct environmental impact.

TABLE 2.29. Motor EROs in Sewage Lift Stations: Energy-Efficient Motors

Existing motor operating parameters

ID	Existing Equipment			No. of Units	Operating Schedule			# Month On-Peak	% Time High Set	Energy Consumption			Sum of Monthly Coincident Demands		
	Equip Code	Type of Motor	Rating HP		(hr/yr)					(kWh)			(kW-mo)		
					on-peak	mid-peak	off-peak			on-peak	mid-peak	off-peak	on-peak	mid-peak	off-peak
1	MLP-30	Lift Pump	30	1	3,788	NA	4,447	12	NA	64,893	NA	76,179	206	NA	NA
2	MLP-5	Lift Pump	5	1	245	NA	288	1	NA	756	NA	888	3.1	NA	NA
3	MLP-7.5	Lift Pump	7.5	1	151	NA	177	0.6	NA	704	NA	826	2.8	NA	NA
4	MLP-90	Lift Pump	90	1	446	NA	524	1.8	NA	29,920	NA	35,124	121	NA	NA
5	MLP-5	Lift Pump	5	1	612	NA	719	2.4	NA	1,875	NA	2,201	7.3	NA	NA
6	MLP-10	Lift Pump	10	1	833	NA	977	3.3	NA	5,044	NA	5,921	20.0	NA	NA
7	MLP-5	Lift Pump	5	1	936	NA	1,099	3.7	NA	2,731	NA	3,205	10.8	NA	NA
8	MLP-5	Lift Pump	5	1	779	NA	914	3.1	NA	2,431	NA	2,853	9.7	NA	NA
9	MLP-3	Lift Pump	3	1	29	NA	34	0.1	NA	64	NA	76	0.2	NA	NA
10	MLP-7.5	Lift Pump	7.5	1	23	NA	26	0.1	NA	103	NA	121	0.5	NA	NA
11	MLP-5	Lift Pump	5	1	455	NA	534	1.8	NA	1,693	NA	1,988	6.7	NA	NA

Energy-efficient motor operating parameters

ID	Energy Resource Opportunity			No. of Units	Operating Schedule			# Month On-Peak	% Time High Sat	Energy Consumption			Sum of Monthly Coincident Demands		
	Equip Code	Type of Motor	Rating HP		(hr/yr)					(kWh)			(kW-mo)		
					on-peak	mid-peak	off-peak			on-peak	mid-peak	off-peak	on-peak	mid-peak	off-peak
1A	MLPE-30	Lift Pump	30	1	3,788	NA	4,447	12	NA	62,944	NA	73,890	199	NA	NA
2A	MLPE-5	Lift Pump	5	1	245	NA	288	1	NA	713	NA	837	2.9	NA	NA
3A	MLPE-7.5	Lift Pump	7.5	1	151	NA	177	0.6	NA	656	NA	770	2.6	NA	NA
4A	MLPE-90	Lift Pump	90	1	446	NA	524	1.8	NA	28,973	NA	34,012	117	NA	NA
5A	MLPE-5	Lift Pump	5	1	612	NA	719	2.4	NA	1,787	NA	2,075	6.9	NA	NA
6A	MLPE-10	Lift Pump	10	1	833	NA	977	3.3	NA	4,789	NA	5,622	19.0	NA	NA
7A	MLPE-5	Lift Pump	5	1	936	NA	1,099	3.7	NA	2,574	NA	3,022	10.2	NA	NA
8A	MLPE-5	Lift Pump	5	1	779	NA	914	3.1	NA	2,291	NA	2,690	9.1	NA	NA
9A	MLPE-3	Lift Pump	3	1	29	NA	34	0.1	NA	59	NA	69	0.2	NA	NA
10	MLPE-7.5	Lift Pump	7.5	1	23	NA	26	0.1	NA	96	NA	113	0.4	NA	NA
11	MLPE-5	Lift Pump	5	1	455	NA	534	1.8	NA	1,596	NA	1,874	6.3	NA	NA

Energy-efficient motor ERO economics

ID	Economic Parameters						First Year Energy & Demand Savings					RI Life Cycle Cost		ROF Life Cycle Cost	
	RI Cost (\$)	ROF Cost (\$)	Before O&M \$	After O&M \$	Life Yr	Salvage \$ RI	Energy (kWh)	Demand (kW-mo)	Energy (1992 \$)	Demand (1992 \$)	Total (1992 \$)	NPV \$	Value Index	NPV \$	Value Index
1A	1,368	1,250	0	0	5	178	4,238	7.0	215	39	253	2,220	1.62	2,332	1.86
2A	422	246	0	0	15	44	94	0.2	5	1	6	(313)	(0.74)	(5)	(0.02)
3A	521	304	0	0	15	60	103	0.2	5	1	6	(400)	(0.77)	(12)	(0.04)
4A	4,736	2,761	0	0	15	618	2,058	4.0	104	22	126	(2,663)	(0.56)	263	0.10
5A	422	246	0	0	15	44	234	0.4	12	2	14	(197)	(0.47)	39	0.18
6A	603	352	0	0	15	72	554	1.0	28	6	34	(132)	(0.22)	109	0.31
7A	422	246	0	0	15	44	340	0.6	17	3	21	(106)	(0.25)	74	0.30
8A	422	246	0	0	15	44	303	0.6	15	3	18	(132)	(0.31)	64	0.26
9A	383	223	0	0	15	36	12	0.0	1	0	1	(356)	(0.93)	(35)	(0.16)
10	521	304	0	0	15	60	15	0.1	1	0.55	1	(471)	(0.90)	(39)	(0.13)
11	69	246	0	0	15	44	211	0.4	11	2	13	(214)	(0.51)	33	0.13

**TABLE 2.30. Motor EROs in Sewage Lift Stations:
Down-Sized and Two-Speed Motors**

Down-sized energy-efficient motor operating parameters

ID	Energy Resource Opportunity			No. of Units	Operating Schedule (hr/yr)			# Month On-Peak	% Time High Set	Energy Consumption (kWh)			Sum of Monthly Coincident Demands (kW-mo)		
	Equip Code	Type of Motor	Rating HP		on-peak	mid-peak	off-peak			on-peak	mid-peak	off-peak	on-peak	mid-peak	off-peak
4B	MLPDE-10	Lift Pump	10	1	2,008	NA	2,357	7.9	NA	14,204	NA	16,674	55.9	NA	NA

Down-sized energy-efficient motor ERO economics

ID	Economic Parameters						First Year Energy & Demand Savings					RI Life Cycle Cost		ROF LifeCycleCost	
	RI Cost (\$)	ROF Cost (\$)	Before O&M \$	After O&M \$	Life Yr	Salvage \$ RI	Energy (kWh)	Demand (kW-mo)	Energy (1992 \$)	Demand (1992 \$)	Total (1992 \$)	NPV \$	Value Index	NPV \$	Value Index
4B	867	505	0	10	8	618	34,166	65	1,729	359	2,088	29,385	33.89	12,489	24.71

2-speed motor operating parameters

ID	Energy Resource Opportunity			No. of Units	Operating Schedule			# Month	% Time	Energy Consumption			Sum of Monthly				
	Equip Code	Type of Motor	Rating HP		(hr/yr)					On-Peak	High Set	(kWh)			Coincident Demands (kW-mo)		
					on-peak	mid-peak	off-peak					on-peak	mid-peak	off-peak	on-peak	mid-peak	off-peak
2C	MLP-5:1.67	Lift Pump	5/1.67	1	438	NA	576	1.8	10	657	NA	394	2.7	NA	NA		
3C	MLP-7.5:2	Lift Pump	7.5/2.5	1	269	NA	355	1.1	10	612	NA	367	2.5	NA	NA		
4C	MLP-90:30	Lift Pump	90/30	1	795	NA	1,048	3.3	10	26,004	NA	15,595	107.9	NA	NA		
5C	MLP-5:1.67	Lift Pump	5/1.67	1	1,092	NA	1,438	4.6	10	1,630	NA	977	6.9	NA	NA		
6C	MLP-10:3.3	Lift Pump	10/3.3	1	1,484	NA	1,955	6.2	10	4,382	NA	2,628	18.3	NA	NA		
7C	MLP-5:1.67	Lift Pump	5/1.67	1	1,669	NA	2,198	7	10	2,374	NA	1,424	10.0	NA	NA		
8C	MLP-5:1.67	Lift Pump	5/1.67	1	1,389	NA	1,829	5.8	10	2,122	NA	1,273	8.9	NA	NA		
9C	MLP-3:1.0	Lift Pump	3/1.0	1	51	NA	68	0.2	10	56	NA	34	0.2	NA	NA		
10	MLP-7.5:2	Lift Pump	7.5/2.5	1	40	NA	53	0.2	10	89	NA	54	0.4	NA	NA		
11	MLP-5:1.67	Lift Pump	5/1.67	1	810	NA	1,067	3.4	10	1,472	NA	882	6.2	NA	NA		

2-speed motor ERO economics

ID	Economic Parameters						First Year Energy & Demand Savings					RI Life Cycle Cost		ROF LifeCycleCost	
	RI Cost (\$)	ROF Cost (\$)	Before O&M \$	After O&M \$	Life Yr	Salvage \$ RI	Energy (kWh)	Demand (kW-mo)	Energy (1992 \$)	Demand (1992 \$)	Total (1992 \$)	NPV \$	Value Index	NPV \$	Value Index
2C	701	409	0	10	15	44	592	0	27	2	29	(508)	(0.73)	(80)	(0.20)
3C	840	490	0	10	15	60	551	0	26	2	27	(693)	(0.82)	(124)	(0.25)
4C	6,369	3,713	0	10	15	618	23,445	13	1,085	71	1,156	9,458	1.49	4,884	1.32
5C	701	409	0	10	15	44	1,469	0	8	2	71	62	0.09	138	0.34
6C	947	552	0	10	15	72	3,955	2	183	9	192	1,485	1.57	725	1.31
7C	701	409	0	10	15	44	2,139	1	99	5	104	529	0.76	316	0.77
8C	701	409	0	10	15	44	1,890	1	87	4	92	366	0.52	253	0.62
9C	622	363	0	10	15	36	50	0	2	0	2	(807)	(1.30)	(208)	(0.57)
10	840	490	0	10	15	60	81	0	4	1	4	(1,014)	(1.21)	(247)	(0.50)
11	701	409	0	10	15	44	1,327	1	61	3	64	(22)	(0.03)	105	0.26

2.11 REFRIGERATION EROs

2.11.1 Replace Domestic Refrigerators with High-Efficiency Models

Description

New appliance standards that came into effect on January 1, 1990, eliminated the most inefficient refrigerator models from the market (Turiet 1990). New standards to take effect on January 1, 1993, will make the least efficient 1993 models 26% to 28% more efficient than the average 1989 model. Although efficient refrigerators are currently available, they are very expensive. When the 1993 standard takes effect, the incremental costs of design features needed to meet the standard are expected to increase the price of mass-produced units by 12.5%. It is reasonable to expect that replacement of all units in 1993 will be economically attractive. A replace-on-failure implementation of this ERO is not considered, because there will be no choice but to replace units that fail after 1993 with units meeting the new standard.

This ERO involves 2,010 compact refrigerators located in Old- and New-Post Barracks, 2,272 full-sized units in on-post family housing and 2,000 units in off-post housing.

Assumptions

Technical data and assumptions that apply to both the barracks and the family housing analyses are as follows:

- The distribution of energy use between on-peak and off-peak periods is assumed to be midway between a distribution based on constant consumption (41% on-peak and 59% off-peak) and the distribution of electric consumption for all electric loads on the post (46% on-peak and 54% off-peak). This is equivalent to a unit with constant demand operating 3,804 hours on-peak and 4,956 hours off-peak.
- Non-energy operations and maintenance (O&M) costs are the same for the retrofit models as for the current models. Refrigerator O&M includes replacement if the refrigeration system fails and repair of shelves and cleaning of coils, drip pans and finished surfaces.

Technical assumptions for the family housing refrigerators are as follows:

- Each family housing unit contains one full-size refrigerator that consumes 1300 kWh per year with an average peak coincident demand of 0.20 kW.
- Existing units are assumed to be 5% less efficient than the 1990 standard. Energy consumption for the 22 ft³ adjusted volume 1993 standard model is 70% that of the 1990 model. Average electric consumption and peak coincident demand of the 1993 retrofit models are therefore taken to be 67% of the consumption and demand of the existing units.

Cost data for the economic analysis in family housing are as follows:

- The installed cost of a comparable full-size 1993 model, purchased in quantity, is \$625 (\$833 retail) or \$587 in 1992 dollars.

Technical assumptions for barracks refrigerators are as follows:

- New-Post barracks rooms (and some of the Old-Post barracks rooms) each contain one compact refrigerator which uses 430 kWh per year with an average peak coincident demand of 0.066 kW.
- Existing units are assumed to be 5% less efficient than the 1990 standard. Energy consumption for the 6 ft³ adjusted volume 1993 standard model is 72% that of the 1990 model. Average electric consumption and peak coincident demand of the 1993 retrofit models are therefore taken to be 69% of the consumption and demand of the existing units.

Cost estimating data used for the barracks analysis are as follows:

- The installed cost of a comparable compact 1993 model, purchased in quantity, is \$225 (\$300 retail) or \$211 in 1992 dollars.

Results

Quantitative results of the ERO analysis are presented in Table 2.31 (p. 2.150). The results are discussed below.

Budget Implications. The first cost to replace barracks refrigerators is \$424,000. The first costs for family housing refrigerators are \$1,334,000 for on-post units and \$1,174,000 for off-post units.

Energy, Demand, and Cost Savings. The electric energy savings in the barracks are estimated to be 314,000 kWh per year at a cost savings of \$15,800 per year. Demand savings are estimated to be 560 kW-month per year with a cost savings of \$3,100 per year.

The electric energy savings in the on-post family housing units are estimated to be 986,000 kWh per year at a cost savings of \$49,500 per year. Demand savings are estimated to be 1,750 kW-month per year with a cost savings of \$9,700 per year.

The electric energy savings in the off-post family housing units are estimated to be 866,000 kWh per year at a cost savings of \$78,000 per year.

Energy Security. This ERO has no impact on energy security.

Operations and Maintenance. There is no additional maintenance requirement for efficient refrigerators.

Environmental Issues. Freon from the replaced refrigerators will have to be properly recycled.

TABLE 2.31. Energy-Efficient Domestic Refrigerator EROs (1993 Replacement)

Existing refrigerator operation/characteristics

ID	Equip Code	Existing Equipment		# of units	Operating Schedule			Peak Factor	Average Load (kW/unit)	Energy Consumption (kWh)			Sum of 12 Monthly coincident demands (kW-mo)		
		Application	Size (cu.ft.)		Hrs on-peak	Hrs mid-peak	Hrs off-peak			on-peak	mid-peak	off-peak	on-peak	mid-peak	off-peak
1	RF-1	Off-Post Housing	18	2,000	NA	8,760	NA	1.3	0.148	NA	2,599,968	NA	NA	NA	NA
2	RF-1	On-Post Housing	18	2,272	3,804	NA	4,956	1.3	0.148	1,129,027	NA	1,470,941	5,260	NA	NA
3	RF-2	Barracks	7	2,010	3,804	NA	4,956	1.3	0.057	492,633	NA	641,822	1,787	NA	NA

Efficient refrigerator operation/characteristics

ID	Equip Code	Existing Equipment		# of units	Operating Schedule			Peak Factor	Average Load (kW/unit)	Energy Consumption (kWh)			Sum of 12 Monthly coincident demands (kW-mo)		
		Application	Size (cu.ft.)		Hrs on-peak	Hrs mid-peak	Hrs off-peak			on-peak	mid-peak	off-peak	on-peak	mid-peak	off-peak
1	REF-1	Off-Post Housing	18	2,000	NA	8,760	NA	1.3	0.099	NA	1,733,399	NA	NA	NA	NA
2	REF-1	On-Post Housing	18	2,272	3,804	NA	4,956	1.3	0.099	752,722	NA	980,676	3,507	NA	NA
3	REF-2	Barracks	7	2,010	3,804	NA	4,956	1.3	0.039	337,799	NA	440,097	1,226	NA	NA

Efficient refrigerator ERO economics

ID	Economic Parameters						First Year Energy & Demand Savings					Life Cycle Cost			
	First Cost ROFS	First Cost RI\$ (1993)	Before O&M \$	After O&M \$	Life (yr)	Salvage (\$)	Energy (kWh)	Demand (kW-mo)	Energy (1992 \$)	Demand (1992 \$)	Total (1992 \$)	No Utility Rebate NPV (\$)	Value Index	50% Utility Rebate NPV (\$)	Value Index
1	NA	1,174,000	NA	NA	10	0	868,000	NA	77,940	0	77,940	(373,646)	-0.32	9,634	0.02
2	NA	1,333,664	NA	NA	10	0	986,048	1,753	49,551	9,659	59,210	(655,570)	-0.49	(158,348)	-0.24
3	NA	424,110	NA	NA	10	0	313,560	562	15,759	3,095	18,854	(208,328)	-0.49	(50,209)	-0.24

2.12 AIR-CONDITIONING EROs

2.12.1 Commercial Window Air-Conditioners

Description

Currently there are 49 window units installed in commercial buildings on the entire post. These units typically serve small areas in otherwise uncooled buildings. The ERO consists of replacing all of these units with new high-efficiency models.

Assumptions

The performance of this ERO is based on the following technical assumptions:

- The existing units average 1.5 tons, with an EER (energy efficiency ratio) of 6.5.
- The units run weekdays only, for six full-load-equivalent hours per day, during the 5 summer months as follows: May, 10 days; June, 20 days; July, 23 days; August, 22 days; September, 10 days. This gives a total of 510 hours per year.
- The units run during the on-peak period at all times, and two-thirds of the time will be contributing to the monthly peak demand.

The economics of this ERO are based on the following cost data:

- The cost of the new 9.0 EER units is \$600 each or about \$100 more per unit than replacement with 6.5 EER units (Grainger 1991). The cost of new 9.5 EER units is \$700 each. The cost of downsized (1.2 ton vs. 1.5 ton) 10.0 EER units is \$650 each.

Results

Quantitative results of the ERO analysis are presented in Table 2.32 (p. 2.153). The results are discussed below.

Budget Implications. The first cost of this ERO is \$31,800 for the most cost-effective implementation.

Energy, Demand, and Cost Savings. The electric energy savings that will result from implementation of this ERO are estimated to be 19,000 kWh per year at a cost savings of \$1,100 per year. Demand savings are estimated to be 124 kW-month per year with a cost savings of \$685 per year.

Energy Security. This ERO has no effect on energy security.

Operations and Maintenance. Since the ERO is a one-for-one replacement involving otherwise similar units of different efficiency, there is no effect on the required O&M.

Environmental Issues. Care should be taken in the disposal of the old units as they may contain CFCs or other environmentally hazardous chemicals and materials. CFCs should be removed and recycled to avoid accidental release to the atmosphere.

TABLE 2.32. Commercial Building Efficient Window Air-Conditioner EROs

Existing window A/C characteristics and operating parameters

ID	Existing Equipment			Density #/SqFt	Total SqFt	# of Units	Operating Schedule			Equiv months	Energy Consumption (kWh)			Sum of 12 Monthly Coincident Demands (kW-m)		
	Equip Code	EER	Rating Ton				Hrs on-peak	Hrs mid-peak	Hrs off-peak		on-peak	mid-peak	off-peak	on-peak	mid-peak	off-peak
1	WAC-1.5	6.5	1.5	NA	NA	49	510	NA	NA	3.3	69,203	NA	NA	448	NA	NA

Efficient window A/C characteristics and operating parameters

ID	Energy Resource Opportunity			Density #/SqFt	Total SqFt	# of Units	Operating Schedule			Equiv months	Energy Consumption (kWh)			Sum of 12 Monthly Coincident Demands (kW-m)		
	Equip Code	EER	Rating Ton				Hrs on-peak	Hrs mid-peak	Hrs off-peak		on-peak	mid-peak	off-peak	on-peak	mid-peak	off-peak
1A	WAC-1.5/9.0	9.0	1.50	NA	NA	49	510	NA	NA	3.3	49,960	NA	NA	323	NA	NA
1B	WAC-1.5/9.5	9.5	1.50	NA	NA	49	510	NA	NA	3.3	47,349	NA	NA	306	NA	NA
1C	WAC-1.2/10.2	10.2	1.17	NA	NA	49	654	NA	NA	3.3	44,110	NA	NA	223	NA	NA

Efficient window A/C ERO economics

ID	First Cost		Non-Energy O&M		Life (yr)	Salvage (\$)	First Year Energy & Demand Savings					RI Life Cycle Cost	
	ROF (1992 \$)	RI (\$)	Before (\$/yr)	After (\$/yr)			Energy (kWh)	Demand (kW-mo)	Energy (1992 \$)	Demand (1992 \$)	Total (1992 \$)	NPV \$	Value Index
1A	NA	29,400	NA	NA	8	0	19,223	124	1,126	685	1,812	1,206	0.04
1B	NA	34,300	NA	NA	8	0	21,854	141	1,280	779	2,060	(6,252)	-0.18
1C	NA	31,850	NA	NA	8	0	25,093	225	1,470	1,241	2,711	8,393	0.26

2.13 TRANSMISSION AND DISTRIBUTION EROs

2.13.1 Energy-Efficient Transformers

There are over 750 electric utility transformers that provide 480/277- and 208/120-volt power to Fort Drum's buildings, streetlights, and other utilities. Transformer losses can be reduced by replacing existing units with low-loss transformers. Low-loss transformers use improved magnetic circuit materials and design to reduce standby (no-load) losses and improved winding design to reduce losses that are primarily a function of load current. Analysis at other sites indicates that it may be cost-effective, as a conservation measure alone, to replace mid-sized (15 to 200 kVA) transformers. Previous studies also indicate that it is always cost-effective to use a low-loss transformer when replacing a failed transformer. However, because the existing transformers at Fort Drum currently have a remaining useful life of 25 years (equivalent to the analysis period), the replace on failure (ROF) option was not analyzed.

Description

Replacement of all 15 kVA and larger distribution transformers by high-efficiency transformers has been analyzed. Replacement of low-voltage (480/277 to 208/120 volt) transformers has not been assessed because data on the quantity, size, and loading were not available and because replacement of such transformers is generally not cost-effective, as a conservation measure alone, due to their small (usually 10 kVA or less) size. Replacement of the main (115 kV primary, 13 kV secondary) substation transformers has not been analyzed given the poor economics demonstrated in the Fort Lewis assessment.

Assumptions

The technical assumptions are as follows:

- On a given feeder, load is distributed according to transformer size. This assumption is used to estimate average load, demand factor, DF, and peak factor (PF) for each transformer.
- Half of the transformer load loss is dissipated during on-peak hours and the balance is dissipated during off-peak hours.

- The load factor (LDF) (ratio of monthly peak to monthly average load), at each transformer is 1.32.
- Annual energy loss (AL) is given by:

$$AL = 8.76(NLL + LF*LL)$$

where NLL = no-load loss in watts
 TL = total loss at full load
 LL = TL - NLL
 LF = $0.3DF + 0.7DF^2$ (correlation per Gönen)
 DF = (average load)/(full load)

- Coincident peak demand (CD) is approximated by:

$$CD = 0.001[NLL + LL(0.3PF + 0.7PF^2)]$$

where PF = LDF*DF

- Peak reactive demand (RD) is given by:

$$RD = 0.001(NLRL + CD\%X/\%R)$$

where %X = per unit reactance
 %R = per unit resistance
 NLRL = the no-load reactive load.

- The values of NLL, NLRL, %X, and %R are taken from (Gönen 1986). They are represented as typical values for standard and high-efficiency transformers of a given size.

Cost estimates are based on the following data.

- Transformer costs are based on Means (1991) data for dry transformers and a correction factor based on Means (1991) data for large oil-filled and dry transformers. Costs to replace some typical units are given below:

<u>ERO Item Description</u>	<u>Material (\$)</u>	<u>Labor (\$)</u>	<u>Total (\$)</u>	<u>Annualized O&M Cost (\$/yr)</u>
37.5 kVA, 1-phase	2,800	630	4,130	no change
150 kVA, 1-phase	7,960	2,180	10,140	no change
150 kVA, 3-phase	9,950	2,730	12,680	no change
500 kVA, 3-phase	14,800	3,990	18,790	no change

- O&M costs are taken to be zero since before and after O&M costs are low and do not differ significantly.

- The salvage value is assumed to be zero for both replace immediately and replace on failure options.

Results

Quantitative results of the ERO analysis are presented in Tables 2.33 and 2.34 (pp.2.163-2.166). The results are discussed below.

Budget Implications. The initial cost for this ERO is \$2,470,000 for the New Post and \$1,860,000 for the Old Post. However, these replace immediately implementations have negative net present values.

Energy, Demand, and Cost Savings. Annual New Post energy savings are estimated to be 600,000 kWh per year, with a cost savings of \$30,000 per year. Demand savings are estimated to be 880 kW-month and 340 excess kVAR-month per year, corresponding to a cost savings of \$5,150 per year.

Annual Old Post energy savings are estimated to be 325,000 kWh per year, with a cost savings of \$16,000 per year. Demand savings are estimated to be 880 kW-month and 400 excess kVAR-month per year, corresponding to cost savings of \$4000 per year.

Energy Security. This ERO has no impact on energy security.

Operations and Maintenance. This ERO will not result in any significant change in maintenance activity.

Environmental Issues. The existing transformers contain non-PCB-bearing oils. There will therefore be no particular environmental hazard in disposal of the transformers. Most of the materials (copper and steel) can be recycled.

2.13.2 Power Factor Correction

Power factor correction reduces losses in the transmission system and generators of the supplying utility and reduces or eliminates excess reactive load charges that a large customer typically incurs each month. The more aggressive power factor correction measures can also reduce losses in a site's distribution lines and transformers.

Low power factors are usually due to the load current lagging the voltage (i.e., to the reactive component of a load). The reactive component

is a significant part of any motor, transformer, or inductive ballast load. The current associated with the reactive component does not contribute to the service provided by the load and does not result directly in a power demand. However, indirect power consumption due to resistance (I^2R) loss occurs in the T&D system.

A lagging power factor can be corrected (brought closer to unity power factor) by installing capacitors. Power-factor-correcting capacitors are most effective when installed at each load that has a reactive component. Power-factor-corrected inductive ballasts are the most common implementation of this approach. However, it is generally not economical to retrofit capacitors to each load because of the high cost per load. The practical alternative implementations are 1) service entrance capacitors (advantage: reduced transformer loss), 2) capacitors on primary and secondary of each distribution transformer (eliminates most of the excitation current with fixed capacitors), 3) at the substation (most economical place to install switched banks or modulating reactors), and 4) distributed along feeder lines.

Description

One of the simplest implementations is considered here because the site's reactive loads are expected to change significantly with implementation of other electric EROs. Power correction by fixed or switched capacitors at the substation will reduce losses in the main transformers that result from lagging power factor but will not affect the corresponding losses in the rest of Fort Drum's distribution system. More importantly, these implementations will reduce losses in NMPC's transmission and generation system and eliminate the excess reactive load charges that Fort Drum has been paying monthly.

The fixed capacitor implementation is sized to provide just enough capacity to eliminate the highest excess reactive demand charges. The switched capacitor implementation provides an additional increment of capacity to maintain close to unity power factor through most seasonal and diurnal variations of the off-peak loads, but only part of the on-peak loads.

Assumptions

The technical assumptions are as follows:

- The ratio of reactive baseload to reactive peak load is taken to be 0.5; i.e., the same as the corresponding ratio of real power baseload to peak load of about 0.5.
- The monthly peak reactive and excess reactive loads from FY 1991 and FY 1992 NMPC billings are 6.5 MVAR and 2.2 MVAR, respectively.
- The annual loss dissipated at the main transformer is given by:

$$AL = 8.76(NLL + LF*LL)$$

where NLL = no-load loss in watts
 TL = total loss at full load
 LL = TL - NLL
 LF = $0.3DF + 0.7DF^2$ (correlation per Gönen 1986)
 DF = (average load amps)/(full load amps).

Loss reduction in the main transformer is seen to result from the reduction in average load amps and is not affected by the no-load loss. The loss parameters and calculations are tabulated below:

<u>SubStn 2</u>	<u>Parameters</u>	<u>(kVAR)</u>	<u>Q/P</u>	<u>PF</u>	<u>DF</u>	<u>LF</u>	<u>(kWh/yr)</u>
Trnsfmr (kVA)	10,000	0	0.55	0.88	0.60	0.43	0
Pavg (kW)	6,800	1700	0.30	0.96	0.65	0.49	38,836
Qavg (kVAR)	3,750	2500	0.18	0.98	0.67	0.51	51,767
LdLoss (kW)	68	3000	0.11	0.99	0.68	0.52	57,022
<u>SubStn 1</u>							
Trnsfmr (kVA)	5,000	0	0.38	0.94	0.62	0.45	0
Pavg (kW)	3,300	600	0.20	0.98	0.65	0.49	10,968
Qavg (kVAR)	1,250	800	0.14	0.99	0.65	0.50	13,327
LdLoss (kW)	35	1000	0.08	1.00	0.66	0.50	14,874

Cost estimates are based on the following data.

- Labor and material costs of the ERO (Means 1991; manufacturers) are as follows:

<u>ERO Item Description</u>	<u>Material (\$/MVA)</u>	<u>Labor (\$/MVA)</u>	<u>Total (\$/MVA)</u>	<u>Annualized O&M Cost (\$/yr)</u>
13 kV static	2,815	695	3,510	0.2%
13 kV synchronous ^(a)	3,320	695	4,015	600 + 0.5%
13 kV switched	4,600	695	5,295	400 + 0.4%
65 kV static	3,455	695	4,150	0.2%

(a) >10 MVAR size.

Results

Quantitative results of the ERO analysis are presented in Table 2.35 (p. 2.167) and are discussed below.

Budget Implications. The total first cost of implementing the switched bank version of the ERO is estimated to be \$19,000.

Energy, Demand, and Cost Savings. Annual energy savings are 35,670 kWh, a cost savings of \$1,780 per year. Demand savings are estimated to be 60 kW-month and 42,720 excess kVAR-month per year, corresponding to a cost savings of \$35,790 per year.

Energy Security. This ERO has no effect on energy security.

Operations and Maintenance. There is a finite probability of equipment failure during the nominal life of the power factor correction equipment. The product of failure probability and replacement cost is reflected in the O&M cost estimate. The switched capacitor unit requires periodic instrument calibration that will add to the cost of the existing annual or biannual substation calibration/preventive maintenance program as indicated.

Environmental Issues. This ERO will have no environmental effect beyond the generally beneficial effects of reduced power generation in the region.

2.13.3 Conservation Voltage Reduction

Energy can be saved by reducing Fort Drum's distribution voltage (nominally 13.2 kV) by a small amount. This approach to energy conservation

is known as conservation voltage reduction (CVR). The magnitude of the voltage reduction is constrained by the requirement that service entrance voltage be maintained above the standard minimum (5% below nominal) at all buildings and other loads on the distribution system.

How a given piece of end-use equipment responds to CVR can be described in terms of input (energy savings), output (service provided), and service life. The most common loads (lights, fans and pumps) respond with input and output reductions approximately proportional to the voltage reduction and a small (but hard to quantify) increase in service life. Loads controlled by feedback (refrigeration, air-conditioning, most electric heaters, and computers or others that involve dc power supplies) respond, on the average, with practically no change in service, energy consumption, or service life.

An aggressive CVR implementation will use feedback from the most heavily loaded transformer near the end of each feeder to regulate substation voltage. A milder implementation will involve simply reducing the main transformer setpoints or tap points at each substation by a small (typically 0.5 to 2%) fixed amount. An intermediate implementation is possible using an open loop control scheme in which the setpoint is varied with load.

Description

The ERO evaluated here consists of changing the voltage tap points of the main (115 kV to 13.2 kV) transformers. A fixed voltage reduction of 1% is appropriate for Fort Drum because the distribution system is not heavily loaded and the simple change in setpoint does not involve any increase in maintenance activity. Open- or closed-loop control schemes are probably not necessary at Fort Drum because the distribution lines and transformers are not heavily loaded.

Assumptions

Technical assumptions are as follows:

- Worst-case building service entrance voltages are currently at least 1% above the minimum acceptable voltage; i.e., a 1% voltage tap point reduction is feasible.

- The average building service voltage is 3% above the minimum.
- A load-to-voltage reduction factor of 0.85 is assumed based on factors of 0.76 for residential, 0.85 for industrial and, 1.00 for commercial (Lovins et al. 1989, p. 296).

Cost associated with the ERO are based on the following data:

- A semi-annual check of distribution voltage is assumed to be a part of the existing preventive maintenance program.
- The labor to change the tap points initially will cost \$200 per transformer; there are two transformers at substation 1 and two at substation 2.

Results

Quantitative results of the ERO analysis are presented in Table 2.36 (p. 2.168). The results are discussed below.

Budget Implications. The total first cost of implementing the ERO is estimated to be \$800.

Energy, Demand, and Cost Savings. Annual energy savings of 740,000 kWh, and cost savings of \$37,500 per year will result from this ERO. Demand savings are estimated to be 1,300 kW-month per year with a cost savings of \$7,200 per year.

Energy Security. This ERO has no effect on energy security.

Operations and Maintenance. There will be little or no net effect on maintenance of distribution system or of end-use equipment.

Environmental Issues. This ERO will have no environmental effect beyond the generally beneficial effects of reduced power generation in the region.

TABLE 2.33. New Post Efficient Transformer EROs

Existing transformer losses

ID	Phs.	Size (kVA)	Qty	Energy		Demand	
				On-Pk (kWh)	Off-Pk (kWh)	True (kW-mo)	Reactive (kVAR-mo)
1	1-Ph	5	0	0	0	0	0
2		7.5	0	0	0	0	0
3		10	0	0	0	0	0
4		15	0	0	0	0	0
5		25	8	4,342	5,998	17	5
6		37.5	37	27,520	38,281	105	40
7		50	55	47,579	65,406	185	80
8		75	57	73,747	102,208	283	133
9		100	0	0	0	0	0
10		167	0	0	0	0	0
11		300	0	0	0	0	0
12	3-Ph	7.5	0	0	0	0	0
13		10	0	0	0	0	0
14		15	0	0	0	0	0
15		25	3	1,856	2,660	7	1
16		30	0	0	0	0	0
17		37.5	0	0	0	0	0
18		45	0	0	0	0	0
19		50	0	0	0	0	0
20		75	3	4,556	6,448	17	3
21		112.5	30	60,060	87,917	226	33
22		150	0	0	0	0	0
23		225	5	17,610	25,319	63	13
24		250	1	3,712	5,359	13	2
25		300	8	32,242	46,959	122	24
26		500	50	318,612	458,772	1,209	352
27		750	2	17,621	23,928	68	128
28		1000	2	18,235	25,593	65	84
29		1500	1	12,718	17,799	45	53
30		2000	1	17,303	23,260	96	281

Efficient transformer losses

ID	Phs.	Size (kVA)	Qty	Energy		Demand	
				On-Peak (kWh)	Off-Peak (kWh)	True (kW-mo)	Reactive (kVAR-mo)
1A	1-Ph	5	0	0	0	0	0
2A		7.5	0	0	0	0	0
3A		10	0	0	0	0	0
4A		15	0	0	0	0	0
5A		25	8	2,605	3,598	10	3
6A		37.5	37	16,512	22,969	63	24
7A		50	55	28,547	39,243	111	48
8A		75	57	44,248	61,325	170	80
9A		100	0	0	0	0	0
10A		167	0	0	0	0	0
11A		300	0	0	0	0	0
12A	3-Ph	7.5	0	0	0	0	0
13A		10	0	0	0	0	0
14A		15	0	0	0	0	0
15A		25	3	1,177	1,659	5	1
16A		30	0	0	0	0	0
17A		37.5	0	0	0	0	0
18A		45	0	0	0	0	0
19A		50	0	0	0	0	0
20A		75	3	2,734	3,869	10	2
21A		112.5	30	38,842	55,556	174	54
22A		150	0	0	0	0	0
23A		225	5	10,855	15,480	39	10
24A		250	1	2,227	3,215	8	1
25A		300	8	20,897	29,727	80	22
26A		500	50	203,304	287,400	803	321
27A		750	2	10,572	14,357	41	77
28A		1,000	2	10,941	15,356	39	50
29A		1,500	1	7,631	10,679	27	32
30A		2,000	1	10,382	13,956	58	169

TABLE 2.33. (contd)

Efficient transformer ERO economics

ID	Total First Cost, RI (\$)	Before O&M (\$/yr)	After O&M (\$/yr)	Life (yr)	Salvage value (\$)	First Year Savings							RI Life Cycle Cost	
						Energy (kWh)	Demand (kW-mo)	XSR Dmd (kVAR-mo)	Energy (1992 \$)	Demand (1992 \$)	XSR Dmd (1992 \$)	Total (1992 \$)	NPV (\$)	Value Index
1A	0	0	0	30	0	0	0	0	0	0	0	0	NA	NA
2A	0	0	0	30	0	0	0	0	0	0	0	0	NA	NA
3A	0	0	0	30	0	0	0	0	0	0	0	0	NA	NA
4A	0	0	0	30	0	0	0	0	0	0	0	0	NA	NA
5A	27,440	0	0	30	0	4,135	7	2	207	37	2	246	(23,981)	-0.87
6A	152,810	0	0	30	0	26,320	42	16	1,316	232	13	1,561	(130,834)	-0.86
7A	273,900	0	0	30	0	45,194	74	32	2,261	407	27	2,696	(235,955)	-0.86
8A	356,870	0	0	30	0	70,382	113	53	3,520	624	44	4,188	(297,915)	-0.83
9A	0	0	0	30	0	0	0	0	0	0	0	0	NA	NA
10A	0	0	0	30	0	0	0	0	0	0	0	0	NA	NA
11A	0	0	0	30	0	0	0	0	0	0	0	0	NA	NA
12A	0	0	0	30	0	0	0	0	0	0	0	0	NA	NA
13A	0	0	0	30	0	0	0	0	0	0	0	0	NA	NA
14A	0	0	0	30	0	0	0	0	0	0	0	0	NA	NA
15A	12,863	0	0	30	0	1,679	1	(0)	84	8	(0)	91	(11,575)	-0.90
16A	0	0	0	30	0	0	0	0	0	0	0	0	NA	NA
17A	0	0	0	30	0	0	0	0	0	0	0	0	NA	NA
18A	0	0	0	30	0	0	0	0	0	0	0	0	NA	NA
19A	0	0	0	30	0	0	0	0	0	0	0	0	NA	NA
20A	23,478	0	0	30	0	4,402	7	1	220	37	1	258	(19,851)	-0.85
21A	302,084	0	0	30	0	53,578	52	(22)	2,661	289	(18)	2,932	(260,804)	-0.86
22A	0	0	0	30	0	0	0	0	0	0	0	0	NA	NA
23A	69,875	0	0	30	0	16,594	24	4	827	132	3	962	(56,337)	-0.81
24A	15,150	0	0	30	0	3,628	5	1	181	29	1	210	(12,191)	-0.80
25A	124,720	0	0	30	0	28,578	42	2	1,420	231	1	1,652	(101,464)	-0.81
26A	939,500	0	0	30	0	286,681	406	31	14,265	2,236	25	16,527	(706,852)	-0.75
27A	45,940	0	0	30	0	16,620	27	51	832	151	42	1,025	(31,507)	-0.69
28A	55,560	0	0	30	0	17,531	26	33	876	144	28	1,047	(40,815)	-0.73
29A	32,765	0	0	30	0	12,207	18	21	610	100	18	727	(22,529)	-0.69
30A	40,615	0	0	30	0	16,225	38	112	813	212	93	1,118	(24,874)	-0.61

TABLE 2.34. Old Post Efficient Transformer EROs

Existing transformer losses

ID	Phs.	Size (kVA)	Qty	Energy Consumption		Demand	
				On-Pk (kWh)	Off-Pk (kWh)	True (kW)	Reactive (kVAR)
1	1-Ph	5	68	12,620	17,624	62	11
2		7.5	2	492	695	2	0
3		10	46	14,281	20,164	64	22
4		15	22	8,174	11,412	41	13
5		25	74	38,528	53,826	201	96
6		37.5	133	95,765	134,448	468	260
7		50	63	52,294	72,713	279	178
8		75	2	2,554	3,553	11	7
9		100	18	28,109	39,304	120	87
10		167	3	7,290	9,918	36	36
11		300	1	4,300	5,771	21	27
12	3-Ph	7.5	1	250	348	1	0
13		10	4	1,610	2,276	7	1
14		15	6	2,951	4,096	13	2
15		25	2	1,374	1,911	6	1
16		30	1	781	1,093	3	1
17		37.5	2	1,934	2,687	9	3
18		45	2	2,045	2,851	9	2
19		50	3	3,318	4,580	15	4
20		75	3	4,838	6,730	21	7
21		112.5	0	0	0	0	0
22		150	2	5,155	7,117	23	14
23		225	6	24,217	33,467	112	61
24		250	0	0	0	0	0
25		300	4	18,259	25,617	78	30
26		500	0	0	0	0	0
27		750	1	9,131	12,285	43	109
28		1,000	0	0	0	0	0
29		1,500	0	0	0	0	0
30		2,000	0	0	0	0	0

Efficient transformer losses

ID	Phs.	Size (kVA)	Qty	Energy Consumption		Demand	
				On-Pk (kWh)	Off-Pk (kWh)	True (kW)	Reactive (kVAR)
1A	1-Ph	5	68	7,572	10,574	37	7
2A		7.5	2	295	417	1	0
3A		10	46	8,569	12,099	38	13
4A		15	22	4,905	6,847	25	8
5A		25	74	23,117	32,296	121	58
6A		37.5	133	57,459	80,668	281	156
7A		50	63	31,376	43,628	168	107
8A		75	2	1,533	2,132	7	4
9A		100	18	16,865	23,583	72	52
10A		167	3	4,374	5,951	21	21
11A		300	1	2,580	3,463	12	16
12A	3-Ph	7.5	1	150	208	1	0
13A		10	4	966	1,365	4	1
14A		15	6	1,770	2,458	8	1
15A		25	2	825	1,146	4	1
16A		30	1	468	656	2	1
17A		37.5	2	1,160	1,612	5	2
18A		45	2	1,227	1,710	5	1
19A		50	3	1,991	2,748	9	3
20A		75	3	2,903	4,038	13	4
21A		112.5	0	0	0	0	0
22A		150	2	3,093	4,270	14	8
23A		225	6	14,530	20,080	67	37
24A		250	0	0	0	0	0
25A		300	4	10,955	15,370	47	18
26A		500	0	0	0	0	0
27A		750	1	5,479	7,371	26	66
28A		1,000	0	0	0	0	0
29A		1,500	0	0	0	0	0
30A		2,000	0	0	0	0	0

TABLE 2.34. (contd)

Efficient transformer ERO economics

ID	Total First Cost, RI (\$)	Before O&M (\$/yr)	After O&M (\$/yr)	Life (yr)	Salvage value (\$)	First Year Savings							RI Life Cycle Cost	
						Energy (kWh)	Demand (kW-mo)	XSR Dmd (kVAR-mo)	Energy (1992 \$)	Demand (1992 \$)	XSR Dmd (1992 \$)	Total (1992 \$)	NPV (\$)	Value Index
1A	73,857	0	0	30	0	12,097	25	4	605	138	4	746	(63,355)	-0.86
2A	3,258	0	0	30	0	475	1	0	24	4	0	28	(2,859)	-0.88
3A	93,869	0	0	30	0	13,778	25	9	688	140	7	835	(82,110)	-0.87
4A	64,701	0	0	30	0	7,834	16	5	392	91	4	487	(57,850)	-0.89
5A	253,820	0	0	30	0	36,942	80	38	1,846	443	32	2,321	(221,145)	-0.87
6A	549,290	0	0	30	0	92,085	187	104	4,601	1,033	86	5,719	(468,778)	-0.85
7A	313,740	0	0	30	0	50,003	112	71	2,500	615	59	3,174	(269,053)	-0.86
8A	12,522	0	0	30	0	2,443	4	3	122	25	2	149	(10,426)	-0.83
9A	145,000	0	0	30	0	26,965	48	35	1,348	265	29	1,641	(121,895)	-0.84
10A	30,432	0	0	30	0	6,883	14	14	345	79	12	435	(24,305)	-0.80
11A	12,472	0	0	30	0	4,028	8	11	202	46	9	257	(8,856)	-0.71
12A	2,036	0	0	30	0	238	0	0	12	2	0	14	(1,834)	-0.90
13A	10,203	0	0	30	0	1,554	3	0	78	15	0	93	(8,897)	-0.87
14A	22,057	0	0	30	0	2,819	5	1	141	29	1	170	(19,659)	-0.89
15A	8,575	0	0	30	0	1,314	2	1	66	13	0	79	(7,457)	-0.87
16A	4,752	0	0	30	0	749	1	0	37	7	0	45	(4,116)	-0.87
17A	10,325	0	0	30	0	1,849	3	1	92	19	1	112	(8,745)	-0.85
18A	11,165	0	0	30	0	1,958	4	1	98	19	1	118	(9,504)	-0.85
19A	18,675	0	0	30	0	3,159	6	2	158	33	1	192	(15,968)	-0.86
20A	23,478	0	0	30	0	4,627	8	3	231	46	2	280	(19,535)	-0.83
21A	0	0	0	30	0	0	0	0	0	0	0	0	NA	NA
22A	25,360	0	0	30	0	4,909	9	6	246	51	5	301	(21,124)	-0.83
23A	83,850	0	0	30	0	23,073	45	25	1,154	246	20	1,420	(63,855)	-0.76
24A	0	0	0	30	0	0	0	0	0	0	0	0	NA	NA
25A	62,360	0	0	30	0	17,550	31	12	877	171	10	1,058	(47,467)	-0.76
26A	0	0	0	30	0	0	0	0	0	0	0	0	NA	NA
27A	22,970	0	0	30	0	8,566	17	44	429	95	36	561	(15,080)	-0.66
28A	0	0	0	30	0	0	0	0	0	0	0	0	NA	NA
29A	0	0	0	30	0	0	0	0	0	0	0	0	NA	NA
30A	0	0	0	30	0	0	0	0	0	0	0	0	NA	NA

TABLE 2.35. Power Factor Correction ERO

Existing power factor characteristics

ID	Equip Code	Application	Size (MVAR)	Density #/SqFt	Total SqFt	# of units	Operating Schedule				Energy Consumption (kWh)			Sum of 12 Monthly Peak			
							Hrs ON	Hrs MID	Hrs OFF	# Month On-Peak	On-Peak	Mid-Peak	Off-Peak	Demand (kW)			Excess kVAR
														On-Peak	Mid-Peak	Off-Peak	
1	NA	SubStn1	0	NA	NA	NA	NA	NA	NA	NA	26,700,000	NA	31,450,000	102,400	NA	NA	14,240
2	NA	SubStn2	0	NA	NA	NA	NA	NA	NA	NA	13,340,000	NA	15,720,000	51,200	NA	NA	7,120

Corrected power factor characteristics

ID	Equip Code	Application	Size (MVAR)	Density #/SqFt	Total SqFt	# of units	Operating Schedule				Energy Consumption (kWh)			Sum of 12 Monthly Peak			
							Hrs ON	Hrs MID	Hrs OFF	# Month On-Peak	On-Peak	Mid-Peak	Off-Peak	Demand (kW)			Excess
														On-Peak	Mid-Peak	Off-Peak	
1A	PFC-1500	SubStn1	1.5	NA	NA	NA	NA	NA	NA	NA	26,699,990	NA	31,449,988	102,400	NA	NA	0
1B	PFC-2000	SubStn1	2.0	NA	NA	NA	NA	NA	NA	NA	26,699,987	NA	31,449,982	102,400	NA	NA	0
2A	PFC-700	SubStn2	0.7	NA	NA	NA	NA	NA	NA	NA	13,333,831	NA	15,710,724	51,174	NA	NA	0
2B	PFC-1000	SubStn2	1.0	NA	NA	NA	NA	NA	NA	NA	13,331,870	NA	15,708,158	51,168	NA	NA	0

Power factor correction economics

ID	First Cost		Before O&M \$	After O&M \$	Life Yr	Salvage \$	First Year Savings				Life Cycle Cost			
	ROF	RI					Energy (kWh)	Demand (kW-mo)	XSR Dmd (kVAR-mo)	Energy (\$)	Demand (\$)	Total \$	NPV \$	Value Index
A	NA	7,722	0	18	25	0	15,699	26	21,360	781	17,875	18,658	254,657	32.98
B	NA	11,402	0	246	25	0	20,004	34	21,360	997	17,915	18,912	251,209	22.03

TABLE 2.36. Conservation Voltage Reduction ERO

Existing operation/characteristics

ID	Equip Code	Application	Xfmr Siz (MVA)	Density #/SqFt	Total SqFt	# of units	Operating Schedule				Energy Consumption (kWh)			Sum of 12 Monthly Peak Demands (kW)		
							Hrs ON	Hrs MID	Hrs OFF	# Month On-Peak	On-Peak	Mid-Peak	Off-Peak	On-Peak	Mid-Peak	Off-Peak
1	MXfmr-1	SubStn1	10	NA	NA	NA	NA	NA	NA	NA	28,700,000	NA	31,450,000	102,400	NA	NA
2	MXfmr-2	SubStn2	20	NA	NA	NA	NA	NA	NA	NA	13,340,000	NA	15,720,000	51,200	NA	NA

Reduced voltage operation/characteristics

ID	Equip Code	Application	Size (CVR %)	Density #/SqFt	Total SqFt	# of units	Operating Schedule				Energy Consumption (KWh)			Sum of 12 Monthly Peak Demands (kW)		
							Hrs ON	Hrs MID	Hrs OFF	# Month On-Peak	On-Peak	Mid-Peak	Off-Peak	On-Peak	Mid-Peak	Off-Peak
1	CVR1-1	SubStn1	1.0%	NA	NA	NA	NA	NA	NA	NA	28,473,050	NA	31,182,875	101,530	NA	NA
2	CVR2-1	SubStn2	1.0%	NA	NA	NA	NA	NA	NA	NA	13,228,810	NA	15,588,380	50,785	NA	NA

Reduced voltage ERO economics

ID	First Cost ROF	First Cost RI	Before O&M \$	After O&M \$	Life Yr	Salvage \$	First Year Savings				Life Cycle Cost	
							Energy (kWh/yr)	Demand (kW-m/yr)	Energy (\$/yr)	Demand (\$/yr)	NPV \$	Value Index
1	NA	400	0	0	25	0	484,275	870	25,011	4,798	419,183	1,047.98
2	NA	400	0	0	25	0	247,010	435	12,488	2,388	208,300	523.25

2.14 MEASURES TO REDUCE ELECTRIC DEMAND CHARGES

2.14.1 Peak Shaving with Existing Diesel Generators

Description

About 10% of Fort Drum's monthly electric bill is demand charges. These charges can be reduced by using existing generators to carry part of the on-post electric load whenever demand approaches the monthly peak. The most reliable and effective way to accomplish this is to convert a given generator from emergency service to a power source that can feed back into the 13.2-kV distribution system. A generator in a building or other facility served by 480-V, 3-phase power is generally a good candidate for conversion if the capacity (kVA) of the existing transformer serving the facility is at least 1.25 times the generator capacity.

The cost per unit energy generated onsite is generally higher than the electric utility's on-peak price per unit energy. However, savings can be realized if the average increase in monthly energy cost due to onsite power generation is outweighed by the average reduction in monthly demand charge.

A mix of generator sizes from 30 to 600 kVA exists at the site. This diversity is useful because it facilitates modulation of the on-post power resource to just maintain the monthly peak demand target that the outside utility sees. It also helps in spreading the load (in terms of annual full-load-equivalent operating hours) equally among the generators.

A frequency synchronizer, capacity control, power factor control, and contactor must be added to convert a generator from emergency service to a power source that can feed back into the 13.2-kV distribution system. Additional components, including larger circuit breakers for the generator and other equipment and distribution panels connected to the transformer secondary, must be added if the generator is capable of producing larger fault currents than the existing electric service. The throttle actuator may also have to be replaced to be compatible with the new capacity control system.

Control of generators has to be centrally coordinated by a dedicated network or as part of an EMCS system. The demand at the revenue meter (in this case, sum of demands at Substations 1 and 2) must be monitored, a monthly

peak limit predicted, and a strategy for starting, stopping, and modulating the output of each generator in the system implemented. A simple strategy that tends to equalize the full-load-equivalent run times follows. The smallest generator will be started whenever demand exceeds a monthly target threshold. When aggregate capacity of the currently running generators is reached, a larger generator will be started; and the generator with the largest cumulative full-load-equivalent run time will be shut off or put on idle standby. This sequence continues as the load increases until the largest generator has come on line. If the load continues to increase, smaller units are brought back on line by selecting the unit with the smallest cumulative full-load-equivalent run time. The process is reversed as the load drops. If the aggregate capacity of the generators is exceeded, the target threshold is adjusted upwards.

Assumptions

The technical parameters and assumed conditions are as follows:

- The generators available for peak shaving are those listed in Table 2.2 of Volume 2 with the following exceptions: 1) The Po Valley lift station cannot be used because its transformer capacity (112.5 kVA) is lower than its generator capacity (130 kVA); and 2) Conversion of generators of less than 70 kVA capacity is not considered because of the relatively large fixed part of the per-generator conversion cost and relatively high maintenance costs.
- Generators will be controlled to operate at unity power factor. This maximizes the capacity of the generating resource and minimizes fuel needed to prevent the peak demand at the utility meter from exceeding a given target demand. Reductions in reactive power crossing the utility meter are probably best achieved by fixed or switched capacitors, as indicated in Section 2.13, rather than by power factor control of the diesel generators.
- The generators on line at any given time can be modulated to just meet the target demand. This assumption is not very realistic for a one-generator system but is very reasonable for a system consisting of three or more different (by factors of 1.3 to 2) size generators.
- Target demand (monthly peak minus aggregate generator capacity) is correctly predicted each month.
- The full nominal aggregate capacity is always available when needed.

- Optimum operation may be realized by not using all of the available capacity every month; however, in this analysis we assume that the total aggregate capacity is used every month, resulting in a conservative assessment of the ERO's cost-effectiveness, but an overprediction of the reduction in kWh purchased from the utility.

The second two assumptions are reasonable because the near-optimum region is fairly flat and the target threshold is adjusted whenever it is exceeded. In months when it is known in advance that a unit will be out of service, the target peak demand can be adjusted accordingly with relatively small impact on net savings.

Costs of the ERO are based on the following cost elements:

- The first-year fuel price is \$0.69 per gallon (#2 fuel oil). The fuel price in future years will vary according to the NIST schedules that apply to DOD facilities. The engine-generator efficiency is 32% resulting in a conversion factor of 12.9 kWh per gallon based on 139,000 HHV Btu/gallon. This yields a fuel cost of \$0.054/kWh.
- The cost of controls, switches, sensors, and communications for a system with one 600-kVA generator are tabulated below.

<u>Description</u>	<u>Material</u>	<u>Labor</u>	<u>Unit Per</u>	<u>Source</u>
Fused PT (Qty 2)	\$1,200	\$250	\$2/kVA	Means (1991)
Current transformer (3)	1,200	150	2/kVA	Means (1991)
Switch	1,900	250	3/kVA	Means (1991)
Speed Control	3,200	600	generator	Woodward Governor
Load and PF control	2,600	500	generator	Woodward Governor
Actuator	1,100	250	generator	Woodward Governor
Field Panel	2,000	500	site	Novar Controls
Phone Line (3 mi)	3,000	0 ^(a)	site	Means (1991) ^(b)
Substn kW monitor	8,000	2,000	system	Novar Controls

(a) Material estimate includes labor.

(b) Cost estimate is very approximate due to unknown conditions.

These costs can be partially aggregated so that total implementation cost can be expressed as \$5,500 per generator site plus \$9,000 per generator plus \$7 per (480-V 3-phase) generator kVA. Note that the cost

of converting the P-11000 (North Entry lift station) generator includes an additional \$20,000 for replacing circuit breakers in the existing motor control center with larger breakers because it appears that this generator can produce fault currents larger than the maximum fault currents possible with the existing service to the building. (It is important to check the need to upsize these circuit breakers in the final design, since this could result in a first cost of \$20,000 less than assumed here.) There is also an additional cost of \$10,000 for the system controller.

- Maintenance costs include routine service required every 200 to 300 hours of full-load-equivalent operation and engine rebuilding every 10,000 to 15,000 hours of full-load equivalent operation. Routine maintenance includes valve lash adjustment and replacement of fluids, filters, and belts.

Maintenance costs for a typical (three-generator) system running 600 full-load-equivalent hours per year (50 hours/month) are given below. The nominal engine overhaul interval is $10,000/600 = 16.7$ years for this system. The costs shown are the rebuilding costs averaged over the expected 16.7-year interval between rebuilds. This simple annualization is conservative, because overhauling is a deferred cost that escalates at a lower rate than the site's discount rate.

Size (kW)	Cost per Engine-Generator Set		Cost per kWh
	Routine (\$/yr)	Engine Rebuild (\$/yr)	Routine + Rebuild (\$/kWh)
600	1018	1854	0.0798
450	796	1396	0.00812
350	645	1090	0.00826

Note: kW weighted average (assume equal equivalent run times): 0.00809.

- When full-load-equivalent operating hours exceed about 100 h/yr, the fuel tank refill frequency with existing tanks becomes excessive. For tank sizes of 2000 gallons or more, a one-month refill interval and corresponding storage capacity of 0.0065 gallons per annual kWh is assumed. For tank sizes under 2000 gallons, a two-month refill interval and corresponding storage capacity of 0.013 gallons per annual kWh is assumed. This results in average tank costs of about 2.25/gallon for units under 100 kW and \$1.50/gallon for units of 100 kW and larger capacity. The smallest system

(consisting of one 600-kW unit) is a unique case requiring no additional fuel storage because it uses less than 50 gallons of diesel fuel per month.

Results

Quantitative results of the ERO analysis are presented in Table 2.37, in which the economics of twelve systems, ranging in peak shaving capacity from 600 to 2900 kW, are presented (see p. 2.176). Note that this measure does not result in net energy savings. It is a fuel-switching measure that saves money. Also note that it does not involve a change in efficiency of existing end-use equipment. Because the ERO provides a portion of the power for all electric loads, the results are presented in terms of total onsite energy use before and after implementation of the generator system. The results are discussed below.

Budget Implications. The first cost for the smallest viable system is \$48,700, and the largest system has a first cost of \$284,000. Enlarging the system costs about \$15,000 per generator conversion. This ERO cannot be implemented in small increments.

The economic attractiveness varies considerably with system capacity, because the fuel consumption (directly proportional to annual kWh production) and operating hours per year are both extremely sensitive to the system's total peak-shaving capacity. These numbers increase rapidly after the first increment of 600 kW. For systems of over 1500 kW capacity, the need for periodic engine rebuilding becomes a budgetary concern: the cost of rebuilding ranges from \$6,000 to \$28,000 per engine. There may be institutional barriers that make it difficult to invest part of the savings that result from this ERO into a fund set up to finance the periodic engine rebuilding and, eventually, replacement that will be required.

Energy, Demand and Cost Savings. The main concern in this resource assessment was how many units should be modified for peak shaving service to maximize NPV of the peak shaving measure. Systems with from one to twelve generators were considered. The one-generator system uses the largest generator on site; the two-generator system consists of the one-generator system plus the next largest generator on the site, and so on. This scheme was

expected to result in the set of highest NPV systems over the range of capacities possible with the existing generators.

The aggregate capacity of each system appears in the third column of the first block of Table 2.37. The NPV of a system is highly sensitive to the energy (kWh) that must be produced to realize its peak shaving capacity. (The energy required is the time-integral of site demand taken between the monthly peak and the monthly peak minus the peak shaving capacity. The integrals were evaluated at a series of values of peak shaving capacity from the demands monitored at Fort Drum between July 1991 and January 1992.) Plots of monthly energy versus peak shaving capacity are presented in Volume 2 of this study series. The energy that must be supplied annually by each system appears in the performance characteristics table under the column headed "Energy Saved." The difference between the change in annual energy and demand costs and the annual fuel costs in the economics table under the column headed "Net Energy Savings."

The results show that 2,900 kW of monthly 15-minute peak demand (34,800 kW-month/yr) can be economically shaved. This represents about 23% of the average billed demand and the percentage is likely to increase as other electric EROs are implemented. Annual electrical energy consumption will be reduced by 5,460 MWh per year, or about 6.5%, while fossil fuel consumption will increase by 59,000 MBtu per year at a cost of \$292,000 per year.

Energy Security. This ERO has a very positive impact on energy security because it provides an emergency power source that can, in principle, be used anywhere on the existing distribution system. The procedure for an extended power outage would be to have building monitors shut off all but essential, predetermined circuits, and to have utility crews shut down street lights and domestic water well pumps that do not have backup generators. Well and lift stations equipped with generators that have not been converted to feed the grid would continue to function on generator power.

Operations and Maintenance. The control system will track operating hours of each generator and alert the operator when refueling and maintenance are due. Maintenance is dominated by oil and filter changes and is roughly proportional to kWh produced. Because this ERO differs from most of the

others by *increasing* the required maintenance effort, it would be desirable to arrange for maintenance by or through the implementation contractor and paid through the savings generated by the measure. Maintenance costs are offset to some extent by the labor for testing the converted generators, which is no longer needed. The O&M costs presented in the table do not account for this and are therefore conservative.

Environmental Issues. Extensive operation of the generators may be environmentally objectionable. Using natural gas-fired generators would reduce emissions and O&M costs. However, the natural gas-fired units are small and their conversion to this application is therefore probably not economic.

TABLE 2.37. Peak Shaving by Existing Generators

Existing system operating parameters

ID	Config Code	Next Size Increment		Density #/SqFt	Total SqFt	No. of Units	Operating Schedule (Full-Load Equivalent Hrs)			Energy Consumption (kWh)			Sum of 12 Monthly Coincident Demands (kW-mo)			Fuel (MBtu)
		Generator Location	Size (kW)				ON	MID	OFF	On-Peak	Mid-Peak	Off-Peak	On-Peak	Mid-Peak	Off-Peak	
0	NA	NA	0	NA	NA	0	0	NA	NA	40,040,000	NA	47,170,000	153,600	NA	NA	0

Peak-shaving system operating parameters

ID	Config Code	Next Size Increment		Density #/SqFt	Total SqFt	No. of Units	Operating Schedule (Full-Load Equivalent Hrs)			Energy Consumption (kWh)			Sum of 12 Monthly Coincident Demands (kW-mo)			Fuel (MBtu)
		Generator Location	Size (kW)				ON	MID	OFF	On-Peak	Mid-Peak	Off-Peak	On-Peak	Mid-Peak	Off-Peak	
1	DGEN-1	P-11000	600	NA	NA	1	13	NA	NA	40,032,270	NA	47,170,000	146,400	NA	NA	84
2	DGEN-2	P-10690	450	NA	NA	2	404	NA	NA	39,816,000	NA	47,170,000	141,000	NA	NA	4,606
3	DGEN-3	P-10000	350	NA	NA	3	626	NA	NA	39,164,000	NA	47,170,000	136,800	NA	NA	9,516
4	DGEN-4	T-2162	350	NA	NA	4	926	NA	NA	38,420,000	NA	47,170,000	132,600	NA	NA	17,597
5	DGEN-5	P-11050	275	NA	NA	5	1,116	NA	NA	37,780,000	NA	47,170,000	129,300	NA	NA	24,549
6	DGEN-6	P-11050	275	NA	NA	6	1,322	NA	NA	37,000,000	NA	47,170,000	126,000	NA	NA	33,022
7	DGEN-7	T-8000	150	NA	NA	7	1,433	NA	NA	36,530,000	NA	47,170,000	124,200	NA	NA	38,128
8	DGEN-8	P-10730	150	NA	NA	8	1,538	NA	NA	36,040,000	NA	47,170,000	122,400	NA	NA	43,450
9	DGEN-9	P-2312	100	NA	NA	9	1,722	NA	NA	35,390,000	NA	47,170,000	121,200	NA	NA	50,511
10	DGEN-10	P-10730	75	NA	NA	10	1,766	NA	NA	35,140,000	NA	47,170,000	120,300	NA	NA	53,227
11	DGEN-11	T-2534	70	NA	NA	11	1,817	NA	NA	34,870,000	NA	47,170,000	119,460	NA	NA	56,160
12	DGEN-12	T-2573	70	NA	NA	12	1,873	NA	NA	34,580,000	NA	47,170,000	118,620	NA	NA	59,310

Peak-shaving ERO economics

ID	First Cost (\$)		O&M (\$/yr)		Life (Yr)	Salvag (\$)	First Year Energy Savings (Costs)							Life Cycle Cost		
	Incremental	Aggregate	Before	After			Energy (kWh)	Demand (kW-mo)	Fuel (MBtu)	Energy (1992 \$)	Demand (1992 \$)	Fuel (1992 \$)	Saving (MBtu)	Net (1992 \$)	NPV \$	Value Index
1	48,700	48,700	0	62	25	0	7,730	7,200	(84)	453	39,672	(417)	(58)	39,707	508,190	10.44
2	17,650	70,463	0	3,444	25	0	424,000	12,600	(4,606)	24,842	69,426	(22,896)	(3,159)	71,372	819,664	11.63
3	16,950	91,797	0	7,240	25	0	876,000	16,800	(9,516)	51,325	92,568	(47,304)	(6,526)	96,589	1,029,334	11.21
4	16,950	115,964	0	13,525	25	0	1,620,000	21,000	(17,597)	94,16	115,710	(87,480)	(12,068)	123,146	1,174,412	10.13
5	16,425	138,597	0	19,112	25	0	2,260,000	24,300	(24,549)	132,413	133,893	(122,040)	(16,836)	144,266	1,270,447	9.17
6	7,425	153,588	0	25,959	25	0	3,040,000	27,600	(33,022)	178,114	152,076	(164,160)	(22,647)	166,030	1,343,534	8.75
7	15,550	173,697	0	30,487	25	0	3,510,000	29,400	(38,128)	205,651	161,994	(189,540)	(26,148)	178,105	1,355,977	7.81
8	15,550	194,000	0	35,262	25	0	4,000,000	31,200	(43,450)	234,360	171,912	(216,000)	(29,798)	190,272	1,362,873	7.03
9	15,200	215,505	0	41,695	25	0	4,650,000	32,400	(50,511)	272,444	178,524	(251,100)	(34,641)	199,868	1,283,870	5.96
10	15,025	237,805	0	44,718	25	0	4,900,000	33,300	(53,227)	287,091	183,483	(264,600)	(36,503)	205,974	1,265,410	5.32
11	14,990	260,652	0	47,984	25	0	5,170,000	34,140	(56,160)	302,910	186,111	(279,180)	(38,514)	211,842	1,236,455	4.74
12	14,990	284,081	0	51,481	25	0	5,460,000	34,980	(59,310)	319,901	192,740	(294,840)	(40,675)	217,801	1,201,800	4.23

3.0 ENERGY RESOURCE OPPORTUNITY IMPACT STUDY

The Energy Resource Opportunities (EROs) described in Section 2.0 of this report were evaluated on the basis of their life-cycle costs. Section 3.1 describes the life-cycle cost evaluation method, and Section 3.2 presents the results of the evaluation. Tables for Section 3 begin on p. 3.6.

3.1 LIFE-CYCLE COST EVALUATION METHOD

Federal agencies are required to evaluate energy-related investments on the basis of minimum life-cycle costs (10 CFR Part 436). A life-cycle cost evaluation computes the total long-run costs of a number of potential actions, and selects the action that minimizes the long-run costs. The life-cycle cost (LCC) of a potential investment is the present value of all of the costs associated with the investment over time. The first step in calculating the LCC is the identification of the relevant costs; these are listed in Table 3.1.

The cost elements cannot simply be summed up when calculating the life-cycle costs, as costs that are borne at different points in time need to be treated differently. This is accomplished through discounting, using the federally mandated discount rate of 4.6% (NIST 1991).

The LCC of an alternative is calculated by summing the installed cost and the present value of the energy cost, the annual O&M cost, and the replacement costs, as shown in Equation 3.1.

$$LCC = IC + PV(EC) + PV(O\&M) + PV(REP) \quad (3.1)$$

where LCC = Life-Cycle Cost

IC = Installed cost

PV(EC) = Present value of annual energy cost

PV(O&M) = Present value of annual O&M cost

PV(REP) = Present value of future replacement cost

This calculation is complicated slightly when considering a "Replace on Failure" ERO, which consists of replacing worn-out equipment with

high-efficiency equipment instead of with identical equipment. In these cases, the installed cost is not paid until the existing equipment wears out. The LCC of these EROs is calculated by treating the installed cost as zero, and incorporating the cost of the high-efficiency replacements in the PV(REP) term. Replace on Failure EROs enjoy a cost advantage in the life-cycle costing methodology, because their installed cost is discounted, while the installed cost of Replace Immediately EROs is paid in full. At the same time, however, Replace on Failure options are penalized in the energy cost component of the LCC calculation. Replace Immediately EROs experience lower energy costs from the start, while Replace on Failure EROs bear high energy costs until the replacement occurs.

Energy resource opportunities are selected for implementation on the basis of their net present value (NPV). The NPV of an ERO is the life-cycle savings of the ERO as compared to not implementing the ERO:

$$NPV = LCC - LCC' \quad (3.2)$$

where NPV = the net present value of the ERO,
LCC = the life-cycle cost of the existing situation,
LCC' = the life-cycle cost if the ERO is implemented.

Most EROs are selected according to a very simple rule: if the NPV is positive, then the project should be undertaken. If the NPV is zero or negative, then the ERO should not be implemented. A positive NPV means the long-run costs of the ERO are less than the long-run costs of the existing situation.

The selection criteria can be complicated by a number of factors. If the ERO is part of a set of mutually exclusive options, then only the option with the highest NPV is selected. For example, oil-fired furnaces in the Administration Buildings on the Old Post can be converted to standard, natural gas furnaces, or they can be replaced with high-efficiency, pulse gas furnaces. The analysis would proceed by calculating the LCC of the existing furnaces, the LCC of converted furnaces, and the LCC of new pulse furnaces.

Depending on the level of operation and the oil and natural gas prices faced, either of the two EROs might be chosen, or it may be optimal to do nothing. If the NPV of both EROs is positive, the highest NPV ERO would be selected.

The value index (VI) is the NPV of an ERO, divided by the cost of implementing the ERO. The VI is used to prioritize a group of minimum LCC EROs. For example, suppose a total of 100 EROs were evaluated. Of these, suppose 25 had negative NPVs, leaving 75 EROs to consider. Of these, say that there are 5 groups of mutually exclusive pairs, and that the highest NPV ERO of each group is selected. This results in the elimination of 5 EROs, for a grand total of 70 EROs to be implemented. Suppose the total cost of implementing all 70 is \$5 million, and the facility has an annual budget for energy conservation projects of \$1 million. The VI would be used to determine which of the 70 EROs provide the greatest "return on investment," thereby deserving immediate implementation.

Calculation of the VI is generally straightforward, as per Equation 3.3.

$$VI = \frac{NPV}{PV(IC)} \quad (3.3)$$

where VI = value index of an ERO,

NPV = net present value of an ERO, and

PV(IC) = present value of the installed cost of an ERO.

Note that the present value of the installed cost is used in the value index. For most EROs, the installed cost is paid at the start of the analysis period, and the present value of the installed cost is therefore equal to the actual installed cost. Some EROs, however, are designated as "Replace on Failure" options, and consist of replacing worn out equipment with high-efficiency equipment instead of with identical equipment. In these cases, the installed cost is not paid until the existing equipment wears out, and so the present value of the first replacement cost is used in calculating the VI.

3.2 SUMMARY OF ERO IMPACT STUDY

Table 3.2 defines the assumptions that are common to all of the EROs analyzed. Table 3.3 defines the column headings used in the remaining tables in this section. The LCC calculations for all EROs for each building type are presented in Table 3.4. Many EROs have negative NPVs, and so are not cost-effective. Many others are cost-effective, but are inferior to an alternative ERO. Table 3.5 gives the life-cycle cost results for all cost-effective EROs that are not excluded by an ERO with a higher NPV and Table 3.6 presents the cumulative values. These are referred to as the "winning" EROs, and make up the list of recommended retrofits. Table 3.6 can be used to calculate total energy and demand savings, total costs, and the total NPV of implementing all cost-effective EROs. These totals are presented in Table 3.7. The total cost-effective efficiency resource at Fort Drum is estimated to be over 230,000 MBtu, or over 15% of annual consumption (see Table 2.1 in Volume 2 for annual totals). This resource would result in annual savings of over \$2.7 million in energy and demand reductions at 1992 fuel prices, or 23% of annual energy costs.

The winning ERO LCC results have been aggregated across building types. These are presented in Table 3.8 with cumulative values in 3.9. The EROs with the highest NPVs are:

- Retrofitting fluorescent lamps and installing occupancy sensors (an NPV of over \$7 million, annual energy savings of over 32,000 MBtu, and nearly \$670,000 worth of energy and demand savings at 1992 fuel prices).
- Replacing incandescent light lamps with compact fluorescent lamps (an NPV of over \$6.5 million, annual energy savings of over 23,000 MBtu, and nearly \$504,000 worth of energy and demand savings at 1992 fuel prices).
- Lowering the temperature of the hot water received from the Jones plant (an NPV of over \$2.8 million, annual energy savings of 39,000 MBtu, and over \$167,000 worth of energy and demand savings at 1992 fuel prices).

Note that one of the highest EROs actually increases annual energy consumption. Using diesel-fueled generators to reduce electricity demand has an NPV of nearly \$1.4 million, while increasing annual fuel consumption by nearly 30,000 MBtu. This ERO has significant cost savings, however, worth over \$190,000 at 1992 fuel prices.

The ERO results have also been combined into a fuel balance table, as presented in Table 3.10. This table shows the quantity conserved for each fuel, the new load for each fuel (many EROs require switching to natural gas, and the peak-shaving EROs require adding diesel), and the net conservation for each fuel.

TABLE 3.1. Cost Elements in a Life-Cycle Cost Analysis

<u>Cost Element</u>	<u>Description</u>	<u>Example</u>
Installed Cost	Cost of materials purchased and the labor required to install them.	Price of an energy efficient lighting fixture, plus cost of labor to install it.
Energy Cost	Annual expenditures on energy to operate equipment.	A lighting fixture that draws 200 watts and operates 2,000 hours annually requires 200 thousand watt-hours (200 kWh) annually. At an electricity price of \$0.10 per kWh, this fixture has an annual energy cost of \$20.00.
Nonfuel operations and maintenance	Expenditures on parts and activities required to operate equipment.	Replacing burned out light bulbs.
Replacement costs	Expenditures to replace equipment upon failure.	Replacing an oil furnace when it is no longer usable.

TABLE 3.2. Assumptions Used in LCC Analysis

Discount Rate: 4.6% real

Analysis Period: 25 years

Current Fuel Prices and Conversion Factors:

<u>Fuel</u>	<u>Purchase Units</u>	<u>Conversion Factor (Purchase Units/MBtu)</u>	<u>Price (1992 \$/ Purchase Unit)</u>	<u>Price (1992 \$/MBtu)</u>
Jones (HTHW)	MBtu	1.0000	\$4.295	\$4.2950
Fuel Oil	Gallons	7.2046	\$0.6900	\$4.9712
Natural Gas				
On-Post	Therms	10.0000	\$0.4430	\$4.4300
Off-Post	Therms	10.0000	\$0.6780	\$6.7800
Propane	Gallons	10.9290	\$0.5494	\$6.0153
Electricity				
On-Post, On-Peak energy	kWh	293.0832	\$0.0586	\$17.1717
On-Post, Off-Peak energy	kWh	293.0832	\$0.0438	\$12.8429
Off-Post, energy	kWh	293.0832	\$0.0900	\$26.3775
On-Post, On-Peak demand	kW	NA	\$5.510	NA

TABLE 3.3. Description of Column Headings

Column Heading	Description	Unit
Area	Area of Fort to which ERO applies: New Fort, Old Fort, on-post housing, or off-post housing.	Area
End Use	Fuel use that is affected by ERO.	End use
Hard Code	Designates the type of building that is affected by the ERO.	Hard Code
Energy Resource Opportunity (ERO)	Describes the ERO. See Section 2 of this Appendix for complete descriptions of each ERO.	ERO
Existing Fuel	Type of fuel used before the ERO for the end use in the area in the building type.	Fuel Type
Resulting Fuel	Type of fuel used after the ERO for the end use in the area in the building type.	Fuel Type
Installed Cost of ERO	Present value of the labor and materials cost of implementing the ERO. Equals actual cost for immediate EROs, discounted cost for replace-on-failure EROs.	1992 Constant Dollars
Present Value of O&M Savings	Present value of the stream of maintenance and replacement cost reductions attributable to the ERO. May be negative, indicating ERO has higher maintenance and replacement costs than the current equipment.	1992 Constant Dollars
Annual Energy Savings	Energy savings that will be realized in first year after implementation of ERO.	MBtu per year
Value of Annual Energy Savings	Energy cost savings that will be realized in first year after implementing ERO	1992 Constant Dollars
Annual Demand Savings	Electricity demand savings that will be realized in first year after implementation of ERO	kW-month per year
Value of Annual Demand Savings	Electricity demand cost savings that will be realized in first year after implementing ERO	1992 Constant Dollars
Net Present Value (NPV) of ERO	Reduction in life-cycle cost due to ERO	1992 Dollars
Value Index	NPV divided by installed cost	None

TABLE 3.4. LCC Results - All EROs

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1992 \$)	Present Value of O&M Savings (1992 \$)	Annual Energy Savings (MBtu)	Value of Annual Energy Savings (1992 \$)	Annual Demand Savings (KW-mo)	Value of Annual Demand Savings (1992 \$)	Net Present Value of ERO (1992 \$)	Value Index
Weather.	Old	Heating	ADM	Ceiling Ins.	Fuel Oil	Fuel Oil	\$71,981	\$0	848	\$4,217	NA	NA	-\$8,831	-0.11
Weather.	Old	Heating	BAR	Ceiling Ins.	Fuel Oil	Fuel Oil	\$130,187	\$0	1,198	\$6,856	NA	NA	-\$29,723	-0.23
Weather.	Old	Heating	CLB	Ceiling Ins.	Fuel Oil	Fuel Oil	\$4,188	\$0	60	\$301	NA	NA	\$886	0.21
Weather.	Old	Heating	COM	Ceiling Ins.	Fuel Oil	Fuel Oil	\$3,481	\$0	38	\$190	NA	NA	-\$272	-0.08
Weather.	Old	Heating	ASS	Ceiling Ins.	Fuel Oil	Fuel Oil	\$14,244	\$0	161	\$761	NA	NA	-\$1,573	-0.11
Weather.	Old	Heating	MED	Ceiling Ins.	Fuel Oil	Fuel Oil	\$7,107	\$0	75	\$375	NA	NA	-\$785	-0.11
Weather.	Old	Heating	OTH	Ceiling Ins.	Fuel Oil	Fuel Oil	\$1,592	\$0	24	\$119	NA	NA	\$421	0.26
Weather.	Old	Heating	MTH	Ceiling Ins.	Fuel Oil	Fuel Oil	\$2,382	\$0	18	\$91	NA	NA	-\$860	-0.36
Weather.	Old	Heating	REC	Ceiling Ins.	Fuel Oil	Fuel Oil	\$6,888	\$0	71	\$356	NA	NA	-\$998	-0.14
Weather.	Old	Heating	SHP	Ceiling Ins.	Fuel Oil	Fuel Oil	\$42,111	\$0	648	\$3,210	NA	NA	-\$12,051	-0.28
Weather.	Old	Heating	WAR	Ceiling Ins.	Fuel Oil	Fuel Oil	\$60,664	\$0	268	\$1,287	NA	NA	-\$28,943	-0.57
Weather.	Old	Heating	SIM	Ceiling Ins.	Fuel Oil	Fuel Oil	\$8,647	\$0	28	\$127	NA	NA	-\$8,497	-0.75
Weather.	Old	Heating	ADM	Floor Ins.	Fuel Oil	Fuel Oil	\$23,807	\$0	398	\$1,884	NA	NA	\$8,674	0.41
Weather.	Old	Heating	BAR	Floor Ins.	Fuel Oil	Fuel Oil	\$38,748	\$0	584	\$2,802	NA	NA	\$8,523	0.22
Weather.	Old	Heating	CLB	Floor Ins.	Fuel Oil	Fuel Oil	\$1,247	\$0	28	\$141	NA	NA	\$1,140	0.81
Weather.	Old	Heating	COM	Floor Ins.	Fuel Oil	Fuel Oil	\$1,038	\$0	18	\$88	NA	NA	\$474	0.48
Weather.	Old	Heating	ASS	Floor Ins.	Fuel Oil	Fuel Oil	\$4,239	\$0	71	\$363	NA	NA	\$1,723	0.41
Weather.	Old	Heating	MED	Floor Ins.	Fuel Oil	Fuel Oil	\$2,115	\$0	36	\$178	NA	NA	\$859	0.41
Weather.	Old	Heating	OTH	Floor Ins.	Fuel Oil	Fuel Oil	\$474	\$0	11	\$56	NA	NA	\$474	1.00
Weather.	Old	Heating	MTH	Floor Ins.	Fuel Oil	Fuel Oil	\$708	\$0	8	\$43	NA	NA	\$12	0.02
Weather.	Old	Heating	REC	Floor Ins.	Fuel Oil	Fuel Oil	\$2,050	\$0	34	\$167	NA	NA	\$739	0.36
Weather.	Old	Heating	SHP	Floor Ins.	Fuel Oil	Fuel Oil	\$12,533	\$0	304	\$1,510	NA	NA	\$12,850	1.03
Weather.	Old	Heating	WAR	Floor Ins.	Fuel Oil	Fuel Oil	\$15,078	\$0	122	\$608	NA	NA	-\$4,859	-0.32
Weather.	Old	Heating	SIM	Floor Ins.	Fuel Oil	Fuel Oil	\$515	\$0	12	\$80	NA	NA	\$497	0.97
Weather.	Old	Heating	ADM	FM System	Fuel Oil	Fuel Oil	\$12,012	\$0	953	\$4,738	NA	NA	\$67,937	5.68
Controls	Old	Heating	BAR	FM System	Fuel Oil	Fuel Oil	\$1,540	\$0	174	\$886	NA	NA	\$13,069	8.48
Controls	Old	Heating	CLB	FM System	Fuel Oil	Fuel Oil	\$616	\$0	88	\$436	NA	NA	\$6,729	10.92
Controls	Old	Heating	COM	FM System	Fuel Oil	Fuel Oil	\$816	\$0	70	\$347	NA	NA	\$6,239	8.51
Controls	Old	Heating	ASS	FM System	Fuel Oil	Fuel Oil	\$4,312	\$0	411	\$2,041	NA	NA	\$30,133	6.88
Controls	Old	Heating	DGR	FM System	Fuel Oil	Fuel Oil	\$616	\$0	50	\$251	NA	NA	\$3,814	5.87
Controls	Old	Heating	MES	FM System	Fuel Oil	Fuel Oil	\$308	\$0	82	\$407	NA	NA	\$6,257	10.16
Controls	Old	Heating	OTH	FM System	Fuel Oil	Fuel Oil	\$824	\$0	27	\$133	NA	NA	\$1,528	6.28
Controls	Old	Heating	REC	FM System	Fuel Oil	Fuel Oil	\$1,232	\$0	140	\$694	NA	NA	\$10,780	11.87
Controls	Old	Heating	SHP	FM System	Fuel Oil	Fuel Oil	\$4,620	\$0	654	\$3,253	NA	NA	\$2,008	1.83
Controls	Old	Heating	WAR	FM System	Fuel Oil	Fuel Oil	\$3,080	\$0	198	\$974	NA	NA	\$50,274	10.88
Weather.	Old	Heating	ADM	Window Quilt	Fuel Oil	Fuel Oil	\$158,425	\$0	2,037	\$10,128	NA	NA	\$13,368	4.34
Weather.	Old	Heating	BAR	Window Quilt	Fuel Oil	Fuel Oil	\$447,120	\$0	5,310	\$26,397	NA	NA	\$12,485	0.08
Weather.	Old	Heating	ASS	Window Quilt	Fuel Oil	Fuel Oil	\$23,909	\$0	282	\$1,451	NA	NA	-\$1,712	-0.00
Weather.	Old	Heating	DGR	Window Quilt	Fuel Oil	Fuel Oil	\$2,138	\$0	47	\$234	NA	NA	\$1,804	0.84
Weather.	Old	Heating	MED	Window Quilt	Fuel Oil	Fuel Oil	\$2,430	\$0	28	\$137	NA	NA	-\$110	-0.06
Weather.	Old	Heating	MES	Window Quilt	Fuel Oil	Fuel Oil	\$14,173	\$0	280	\$1,442	NA	NA	\$10,157	0.72
Weather.	Old	Heating	REC	Window Quilt	Fuel Oil	Fuel Oil	\$7,802	\$0	97	\$481	NA	NA	\$214	0.03
Weather.	Old	Heating	ADM	Weatherstrip	Fuel Oil	Fuel Oil	\$39,338	\$0	1,317	\$6,549	NA	NA	\$71,159	1.81
Weather.	Old	Heating	BAM	Weatherstrip	Fuel Oil	Fuel Oil	\$178	\$0	153	\$762	NA	NA	\$12,877	71.22
Weather.	Old	Heating	BAR	Weatherstrip	Fuel Oil	Fuel Oil	\$35,244	\$0	1,880	\$9,246	NA	NA	\$120,771	3.43
Weather.	Old	Heating	CLB	Weatherstrip	Fuel Oil	Fuel Oil	\$712	\$0	94	\$467	NA	NA	\$7,167	10.07
Weather.	Old	Heating	CLD	Weatherstrip	Fuel Oil	Fuel Oil	\$178	\$0	39	\$191	NA	NA	\$3,053	17.15
Weather.	Old	Heating	COM	Weatherstrip	Fuel Oil	Fuel Oil	\$1,068	\$0	59	\$295	NA	NA	\$3,914	3.88
Weather.	Old	Heating	ASS	Weatherstrip	Fuel Oil	Fuel Oil	\$6,162	\$0	236	\$1,166	NA	NA	\$14,515	2.81
Weather.	Old	Heating	DGR	Weatherstrip	Fuel Oil	Fuel Oil	\$1,602	\$0	100	\$499	NA	NA	\$6,820	4.26
Weather.	Old	Heating	HAN	Weatherstrip	Fuel Oil	Fuel Oil	\$178	\$0	81	\$404	NA	NA	\$6,848	37.34
Weather.	Old	Heating	HOT	Weatherstrip	Fuel Oil	Fuel Oil	\$178	\$0	16	\$78	NA	NA	\$1,135	6.37
Weather.	Old	Heating	HSP	Weatherstrip	Fuel Oil	Fuel Oil	\$178	\$0	68	\$328	NA	NA	\$5,364	30.13
Weather.	Old	Heating	LAU	Weatherstrip	Fuel Oil	Fuel Oil	\$358	\$0	28	\$127	NA	NA	\$1,784	5.01

TABLE 3.4. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1982 \$)	Present Value of O&M Savings (1982 \$)	Annual Energy Savings (MMBtu)	Value of Annual Energy Savings (1982 \$)	Annual Demand Savings (KW-mo)	Value of Annual Demand Savings (1982 \$)	Net Present Value of ERO (1982 \$)	Value Index
Weather.	Old	Heating	MED	Weatherstrip	Fuel Oil	Fuel Oil	\$2,070	\$0	117	\$592	NA	NA	\$7,147	2.88
Weather.	Old	Heating	MED	Weatherstrip	Fuel Oil	Fuel Oil	\$8,942	\$0	286	\$1,419	NA	NA	\$16,994	2.46
Weather.	Old	Heating	OTH	Weatherstrip	Fuel Oil	Fuel Oil	\$1,780	\$0	37	\$185	NA	NA	\$1,347	0.78
Weather.	Old	Heating	MTH	Weatherstrip	Fuel Oil	Fuel Oil	\$1,248	\$0	28	\$141	NA	NA	\$1,132	0.91
Weather.	Old	Heating	REC	Weatherstrip	Fuel Oil	Fuel Oil	\$1,602	\$0	111	\$551	NA	NA	\$7,703	4.81
Weather.	Old	Heating	SHR	Weatherstrip	Fuel Oil	Fuel Oil	\$8,588	\$0	1,003	\$4,984	NA	NA	\$77,518	11.77
Weather.	Old	Heating	WAR	Weatherstrip	Fuel Oil	Fuel Oil	\$18,166	\$0	402	\$1,999	NA	NA	\$15,572	0.86
Weather.	Old	Heating	SIM	Weatherstrip	Fuel Oil	Fuel Oil	\$178	\$0	40	\$198	NA	NA	\$3,161	17.76
Furn. & Bld.	Old	Heating	ADM	Furnace C-Old	Fuel Oil	Fuel Oil	\$224,000	\$50,048	4,481	\$28,701	NA	NA	\$255,022	1.14
Furn. & Bld.	Old	Heating	BAR	Furnace C-Old	Fuel Oil	Fuel Oil	\$173,780	\$32,289	4,004	\$25,784	NA	NA	\$243,685	1.40
Furn. & Bld.	Old	Heating	CLB	Furnace C-Old	Fuel Oil	Fuel Oil	\$11,880	\$2,422	280	\$1,865	NA	NA	\$18,403	1.55
Furn. & Bld.	Old	Heating	COM	Furnace C-Old	Fuel Oil	Fuel Oil	\$7,460	\$1,814	220	\$1,413	NA	NA	\$15,270	2.05
Furn. & Bld.	Old	Heating	ASS	Furnace C-Old	Fuel Oil	Fuel Oil	\$18,050	\$4,843	265	\$1,703	NA	NA	\$12,246	0.88
Furn. & Bld.	Old	Heating	DGR	Furnace C-Old	Fuel Oil	Fuel Oil	\$24,780	\$4,843	845	\$5,439	NA	NA	\$81,355	2.48
Furn. & Bld.	Old	Heating	LAU	Furnace C-Old	Fuel Oil	Fuel Oil	\$4,430	\$807	85	\$549	NA	NA	\$4,587	1.04
Furn. & Bld.	Old	Heating	MED	Furnace C-Old	Fuel Oil	Fuel Oil	\$20,760	\$4,036	448	\$2,881	NA	NA	\$26,344	1.27
Furn. & Bld.	Old	Heating	MES	Furnace C-Old	Fuel Oil	Fuel Oil	\$50,980	\$13,723	1,230	\$7,911	NA	NA	\$80,878	1.59
Furn. & Bld.	Old	Heating	OTH	Furnace C-Old	Fuel Oil	Fuel Oil	\$7,460	\$1,814	183	\$1,241	NA	NA	\$12,701	1.70
Furn. & Bld.	Old	Heating	MTH	Furnace C-Old	Fuel Oil	Fuel Oil	\$6,000	\$1,814	30	\$192	NA	NA	\$1,574	-0.26
Furn. & Bld.	Old	Heating	REC	Furnace C-Old	Fuel Oil	Fuel Oil	\$4,430	\$807	102	\$658	NA	NA	\$6,182	1.40
Furn. & Bld.	Old	Heating	SHR	Furnace C-Old	Fuel Oil	Fuel Oil	\$42,360	\$9,887	1,636	\$10,618	NA	NA	\$124,533	2.94
Furn. & Bld.	Old	Heating	WAR	Furnace C-Old	Fuel Oil	Fuel Oil	\$122,130	\$25,024	1,562	\$10,061	NA	NA	\$63,115	0.43
Furn. & Bld.	Old	Heating	ADM	Furnace S-Old	Fuel Oil	Fuel Oil	\$147,270	\$50,048	2,643	\$20,650	NA	NA	\$187,678	1.27
Furn. & Bld.	Old	Heating	BAR	Furnace S-Old	Fuel Oil	Fuel Oil	\$109,180	\$32,289	2,373	\$18,537	NA	NA	\$178,763	1.86
Furn. & Bld.	Old	Heating	CLB	Furnace S-Old	Fuel Oil	Fuel Oil	\$7,590	\$2,422	108	\$1,086	NA	NA	\$8,392	1.11
Furn. & Bld.	Old	Heating	COM	Furnace S-Old	Fuel Oil	Fuel Oil	\$4,880	\$1,814	130	\$1,018	NA	NA	\$10,773	2.22
Furn. & Bld.	Old	Heating	DGR	Furnace S-Old	Fuel Oil	Fuel Oil	\$12,650	\$4,843	157	\$1,225	NA	NA	\$9,091	0.72
Furn. & Bld.	Old	Heating	ASS	Furnace S-Old	Fuel Oil	Fuel Oil	\$15,310	\$4,843	501	\$3,913	NA	NA	\$43,504	2.84
Furn. & Bld.	Old	Heating	LAU	Furnace S-Old	Fuel Oil	Fuel Oil	\$2,730	\$807	51	\$395	NA	NA	\$3,527	1.29
Furn. & Bld.	Old	Heating	MED	Furnace S-Old	Fuel Oil	Fuel Oil	\$13,050	\$4,036	285	\$2,073	NA	NA	\$18,573	1.50
Furn. & Bld.	Old	Heating	MES	Furnace S-Old	Fuel Oil	Fuel Oil	\$35,690	\$13,723	729	\$5,892	NA	NA	\$58,537	1.58
Furn. & Bld.	Old	Heating	OTH	Furnace S-Old	Fuel Oil	Fuel Oil	\$4,880	\$1,814	114	\$893	NA	NA	\$9,087	1.87
Furn. & Bld.	Old	Heating	MTH	Furnace S-Old	Fuel Oil	Fuel Oil	\$4,280	\$1,814	18	\$138	NA	NA	\$-739	-0.17
Furn. & Bld.	Old	Heating	REC	Furnace S-Old	Fuel Oil	Fuel Oil	\$2,730	\$807	60	\$472	NA	NA	\$4,587	1.88
Furn. & Bld.	Old	Heating	SHR	Furnace S-Old	Fuel Oil	Fuel Oil	\$32,630	\$9,887	989	\$7,588	NA	NA	\$81,427	2.50
Furn. & Bld.	Old	Heating	WAR	Furnace S-Old	Fuel Oil	Fuel Oil	\$27,160	\$25,024	926	\$7,232	NA	NA	\$48,537	0.86
Furn. & Bld.	Old	Heating	ADM	Furnace S-Old	Fuel Oil	Fuel Oil	\$247,850	\$102,517	478	\$15,049	NA	NA	\$1,394	0.01
Furn. & Bld.	Old	Heating	BAR	Convert F-New	Fuel Oil	Fuel Oil	\$313,950	\$129,863	1,074	\$33,807	NA	NA	\$146,178	0.46
Furn. & Bld.	Old	Heating	COM	Convert F-New	Fuel Oil	Fuel Oil	\$1,950	\$807	1	\$45	NA	NA	\$-700	-0.38
Furn. & Bld.	Old	Heating	ASS	Convert F-New	Fuel Oil	Fuel Oil	\$23,400	\$9,887	78	\$2,484	NA	NA	\$10,282	0.44
Furn. & Bld.	Old	Heating	MED	Convert F-New	Fuel Oil	Fuel Oil	\$3,900	\$1,814	17	\$547	NA	NA	\$3,040	0.78
Furn. & Bld.	Old	Heating	MES	Convert F-New	Fuel Oil	Fuel Oil	\$11,700	\$4,843	43	\$1,361	NA	NA	\$6,398	0.65
Furn. & Bld.	Old	Heating	OTH	Convert F-New	Fuel Oil	Fuel Oil	\$37,050	\$15,337	110	\$3,460	NA	NA	\$11,975	0.32
Furn. & Bld.	Old	Heating	REC	Convert F-New	Fuel Oil	Fuel Oil	\$1,950	\$807	16	\$499	NA	NA	\$2,776	1.91
Furn. & Bld.	Old	Heating	SHR	Convert F-New	Fuel Oil	Fuel Oil	\$7,800	\$4,036	7	\$231	NA	NA	\$-1,519	-0.19
Furn. & Bld.	Old	Heating	WAR	Convert F-New	Fuel Oil	Fuel Oil	\$25,350	\$11,301	135	\$4,240	NA	NA	\$27,231	1.07
Furn. & Bld.	Old	Heating	ADM	Convert F-New	Fuel Oil	Fuel Oil	\$72,150	\$29,887	95	\$2,993	NA	NA	\$-13,143	-0.19
Furn. & Bld.	Old	Heating	BAR	Boiler P-Old	Fuel Oil	Fuel Oil	\$90,980	\$9,887	822	\$5,658	NA	NA	\$879	0.01
Furn. & Bld.	Old	Heating	CLB	Boiler P-Old	Fuel Oil	Fuel Oil	\$45,480	\$4,843	741	\$5,104	NA	NA	\$33,440	0.74
Furn. & Bld.	Old	Heating	COM	Boiler P-Old	Fuel Oil	Fuel Oil	\$15,180	\$1,814	378	\$3,119	NA	NA	\$28,499	1.88
Furn. & Bld.	Old	Heating	ASS	Boiler P-Old	Fuel Oil	Fuel Oil	\$7,580	\$807	213	\$1,471	NA	NA	\$14,574	1.92
Furn. & Bld.	Old	Heating	MED	Boiler P-Old	Fuel Oil	Fuel Oil	\$45,480	\$4,843	420	\$3,174	NA	NA	\$3,712	0.08
Furn. & Bld.	Old	Heating	HSP	Boiler P-Old	Fuel Oil	Fuel Oil	\$7,580	\$807	455	\$3,447	NA	NA	\$41,364	5.46
Furn. & Bld.	Old	Heating	LAU	Boiler P-Old	Fuel Oil	Fuel Oil	\$7,580	\$807	155	\$1,088	NA	NA	\$8,721	1.15
Furn. & Bld.	Old	Heating	MED	Boiler P-Old	Fuel Oil	Fuel Oil	\$15,180	\$1,814	118	\$810	NA	NA	\$-1,792	-0.12

TABLE 3.4. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1992 \$)	Present Value of O&M Savings (1992 \$)	Annual Energy Savings (MMBtu)	Value of Annual Energy Savings (1992 \$)	Annual Demand Savings (KW-mo)	Value of Annual Demand Savings (1992 \$)	Net Present Value of ERO (1992 \$)	Value Index
Furn. & Bire.	Old	Heating	OTH	Boiler P-Old	Fuel Oil	Nat. Gas (d)	\$7,580	\$807	87	\$463	NA	NA	-\$46	-0.01
Furn. & Bire.	Old	Heating	MTH	Boiler P-Old	Fuel Oil	Nat. Gas (d)	\$7,580	\$807	45	\$308	NA	NA	-\$2,298	-0.30
Furn. & Bire.	Old	Heating	REC	Boiler P-Old	Fuel Oil	Nat. Gas (d)	\$7,580	\$807	45	\$308	NA	NA	-\$2,308	-0.30
Furn. & Bire.	Old	Heating	SHR	Boiler P-Old	Fuel Oil	Nat. Gas (d)	\$113,700	\$12,108	2,485	\$17,121	NA	NA	\$146,887	1.28
Furn. & Bire.	Old	Heating	WAR	Boiler P-Old	Fuel Oil	Nat. Gas (d)	\$109,120	\$11,301	638	\$4,440	NA	NA	-\$30,838	-0.28
Furn. & Bire.	Old	Heating	ADM	Boiler P-Old	Fuel Oil	Nat. Gas (d)	\$85,120	\$9,887	484	\$4,161	NA	NA	-\$4,086	-0.08
Furn. & Bire.	Old	Heating	BAR	Boiler P-Old	Fuel Oil	Nat. Gas (d)	\$34,560	\$4,843	438	\$3,762	NA	NA	\$20,317	0.59
Furn. & Bire.	Old	Heating	CLB	Boiler P-Old	Fuel Oil	Nat. Gas (d)	\$11,520	\$1,614	222	\$2,437	NA	NA	\$19,928	1.73
Furn. & Bire.	Old	Heating	COM	Boiler P-Old	Fuel Oil	Nat. Gas (d)	\$5,760	\$807	128	\$1,084	NA	NA	\$9,486	1.84
Furn. & Bire.	Old	Heating	ASS	Boiler P-Old	Fuel Oil	Nat. Gas (d)	\$34,560	\$4,843	315	\$2,708	NA	NA	\$6,301	0.18
Furn. & Bire.	Old	Heating	HSP	Boiler E-Old	Fuel Oil	Nat. Gas (d)	\$5,760	\$807	289	\$2,622	NA	NA	\$28,406	4.83
Furn. & Bire.	Old	Heating	LAU	Boiler E-Old	Fuel Oil	Nat. Gas (d)	\$5,760	\$807	92	\$787	NA	NA	\$5,512	0.98
Furn. & Bire.	Old	Heating	MED	Boiler E-Old	Fuel Oil	Nat. Gas (d)	\$11,520	\$1,614	89	\$587	NA	NA	-\$1,967	-0.17
Furn. & Bire.	Old	Heating	OTH	Boiler E-Old	Fuel Oil	Nat. Gas (d)	\$5,760	\$807	40	\$342	NA	NA	-\$407	-0.07
Furn. & Bire.	Old	Heating	MTH	Boiler E-Old	Fuel Oil	Nat. Gas (d)	\$5,760	\$807	28	\$227	NA	NA	-\$1,931	-0.34
Furn. & Bire.	Old	Heating	REC	Boiler E-Old	Fuel Oil	Nat. Gas (d)	\$5,760	\$807	28	\$227	NA	NA	-\$1,937	-0.34
Furn. & Bire.	Old	Heating	SHR	Boiler E-Old	Fuel Oil	Nat. Gas (d)	\$89,400	\$12,108	1,488	\$12,817	NA	NA	\$83,534	1.08
Furn. & Bire.	Old	Heating	WAR	Boiler E-Old	Fuel Oil	Nat. Gas (d)	\$89,400	\$12,108	388	\$3,330	NA	NA	-\$25,048	-0.31
Furn. & Bire.	Old	Heating	ADM	Convert B-New	Fuel Oil	Nat. Gas (d)	\$89,100	\$14,630	249	\$5,686	NA	NA	\$2,824	0.04
Furn. & Bire.	Old	Heating	BAM	Convert B-New	Fuel Oil	Nat. Gas (d)	\$10,900	\$2,422	184	\$4,132	NA	NA	\$34,073	3.15
Furn. & Bire.	Old	Heating	BAR	Convert B-New	Fuel Oil	Nat. Gas (d)	\$34,800	\$7,265	205	\$4,617	NA	NA	\$19,898	0.67
Furn. & Bire.	Old	Heating	CLD	Convert B-New	Fuel Oil	Nat. Gas (d)	\$7,200	\$1,614	46	\$1,039	NA	NA	\$5,086	0.71
Furn. & Bire.	Old	Heating	COM	Convert B-New	Fuel Oil	Nat. Gas (d)	\$3,000	\$807	12	\$276	NA	NA	\$36	0.01
Furn. & Bire.	Old	Heating	ASS	Convert B-New	Fuel Oil	Nat. Gas (d)	\$18,000	\$4,038	54	\$1,223	NA	NA	-\$1,402	-0.08
Furn. & Bire.	Old	Heating	HOT	Convert B-New	Fuel Oil	Nat. Gas (d)	\$7,200	\$807	19	\$422	NA	NA	\$1,542	0.43
Furn. & Bire.	Old	Heating	MED	Convert B-New	Fuel Oil	Nat. Gas (d)	\$15,000	\$4,038	10	\$219	NA	NA	-\$3,338	-0.46
Furn. & Bire.	Old	Heating	OTH	Convert B-New	Fuel Oil	Nat. Gas (d)	\$14,935	\$3,228	45	\$1,022	NA	NA	-\$3,486	-0.19
Furn. & Bire.	Old	Heating	MTH	Convert B-New	Fuel Oil	Nat. Gas (d)	\$26,970	\$4,843	198	\$4,447	NA	NA	-\$9,180	-0.81
Furn. & Bire.	Old	Heating	REC	Convert B-New	Fuel Oil	Nat. Gas (d)	\$82,136	\$11,301	776	\$17,408	NA	NA	\$23,580	0.87
Furn. & Bire.	Old	Heating	SHR	Convert B-New	Fuel Oil	Nat. Gas (d)	\$43,735	\$9,887	110	\$2,472	NA	NA	-\$8,664	-0.20
Furn. & Bire.	Old	Heating	WAR	Convert B-New	Fuel Oil	Nat. Gas (d)	\$7,200	\$1,514	48	\$1,073	NA	NA	\$5,441	0.76
Furn. & Bire.	Old	Heating	SIM	Convert B-New	Fuel Oil	Nat. Gas (d)	\$85,311	\$34,711	420	\$3,763	NA	NA	-\$5,391	-0.06
Hot Water	Old	Hot Water	ADM	New DWH	Fuel Oil	Nat. Gas (d)	\$2,077	\$807	42	\$2,076	NA	NA	\$17,928	8.63
Hot Water	Old	Hot Water	BAM	New DWH	Fuel Oil	Nat. Gas (d)	\$378,014	\$148,914	4,188	\$37,436	NA	NA	\$258,731	0.88
Hot Water	Old	Hot Water	BAR	New DWH	Fuel Oil	Nat. Gas (d)	\$18,993	\$7,286	233	\$2,083	NA	NA	\$15,889	0.86
Hot Water	Old	Hot Water	ASS	New DWH	Fuel Oil	Nat. Gas (d)	\$2,077	\$807	30	\$285	NA	NA	\$2,209	1.08
Hot Water	Old	Hot Water	HOT	New DWH	Fuel Oil	Nat. Gas (d)	\$2,077	\$807	75	\$674	NA	NA	\$7,568	3.84
Hot Water	Old	Hot Water	HSP	New DWH	Fuel Oil	Nat. Gas (d)	\$2,077	\$807	8	\$78	NA	NA	-\$276	-0.13
Hot Water	Old	Hot Water	LAU	New DWH	Fuel Oil	Nat. Gas (d)	\$22,847	\$8,879	202	\$1,802	NA	NA	\$9,664	0.42
Hot Water	Old	Hot Water	MED	New DWH	Fuel Oil	Nat. Gas (d)	\$39,483	\$16,337	240	\$2,150	NA	NA	\$4,064	0.10
Hot Water	Old	Hot Water	REC	New DWH	Fuel Oil	Nat. Gas (d)	\$6,231	\$2,422	119	\$1,084	NA	NA	\$10,141	1.83
Hot Water	Old	Hot Water	SHR	New DWH	Fuel Oil	Nat. Gas (d)	\$10,386	\$4,038	658	\$5,887	NA	NA	\$70,576	6.80
Hot Water	Old	Hot Water	WAR	New DWH	Fuel Oil	Nat. Gas (d)	\$31,155	\$12,108	65	\$577	NA	NA	-\$11,480	-0.37
Hot Water	Old	Hot Water	SIM	New DWH	Fuel Oil	Nat. Gas (d)	\$2,077	\$807	28	\$260	NA	NA	\$2,012	0.97
Hot Water	Old	Heating	ADM	Tune B All	Fuel Oil	Fuel Oil	\$7,500	\$0	421	\$2,080	NA	NA	\$19	0.00
Furn. & Bire.	Old	Heating	BAM	Tune B All	Fuel Oil	Fuel Oil	\$7,500	\$0	216	\$1,087	NA	NA	\$3,086	4.12
Furn. & Bire.	Old	Heating	BAR	Tune B All	Fuel Oil	Fuel Oil	\$3,750	\$0	358	\$1,778	NA	NA	\$2,644	0.70
Furn. & Bire.	Old	Heating	CLB	Tune B All	Fuel Oil	Fuel Oil	\$500	\$0	94	\$487	NA	NA	\$1,180	2.38
Furn. & Bire.	Old	Heating	CLD	Tune B All	Fuel Oil	Fuel Oil	\$500	\$0	54	\$288	NA	NA	\$464	0.93
Furn. & Bire.	Old	Heating	COM	Tune B All	Fuel Oil	Fuel Oil	\$500	\$0	48	\$240	NA	NA	\$383	0.73
Furn. & Bire.	Old	Heating	ASS	Tune B All	Fuel Oil	Fuel Oil	\$2,750	\$0	148	\$738	NA	NA	-\$98	-0.04
Furn. & Bire.	Old	Heating	HOT	Tune B All	Fuel Oil	Fuel Oil	\$250	\$0	22	\$109	NA	NA	\$142	0.57
Furn. & Bire.	Old	Heating	HSP	Tune B All	Fuel Oil	Fuel Oil	\$250	\$0	92	\$480	NA	NA	\$1,404	5.82
Furn. & Bire.	Old	Heating	LAU	Tune B All	Fuel Oil	Fuel Oil	\$250	\$0	25	\$123	NA	NA	\$191	0.78

TABLE 3.4. (contd)

Energy Resource Opportunity Category	Area	End Use	HAC CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1982 \$)	Present Value of O&M Savings (1982 \$)	Annual Energy Savings (MBtu)	Value of Annual Energy Savings (1982 \$)	Annual Demand Savings (KW-mo)	Value of Annual Demand Savings (1982 \$)	Net Present Value of ERC (1982 \$)	Value Index
Furn. & Birs.	Old	Heating	MED	Tune B All	Fuel Oil	Fuel Oil	\$1,000	\$0	30	\$149	NA	NA	-\$462	-0.46
Furn. & Birs.	Old	Heating	OTH	Tune B All	Fuel Oil	Fuel Oil	\$1,500	\$0	64	\$317	NA	NA	-\$360	-0.24
Furn. & Birs.	Old	Heating	MTH	Tune B All	Fuel Oil	Fuel Oil	\$1,250	\$0	20	\$89	NA	NA	-\$82	-0.71
Furn. & Birs.	Old	Heating	REC	Tune B All	Fuel Oil	Fuel Oil	\$1,750	\$0	238	\$1,183	NA	NA	\$2,508	1.43
Furn. & Birs.	Old	Heating	SHR	Tune B All	Fuel Oil	Fuel Oil	\$7,250	\$0	1,288	\$8,468	NA	NA	\$15,978	2.20
Furn. & Birs.	Old	Heating	WAR	Tune B All	Fuel Oil	Fuel Oil	\$6,500	\$0	233	\$1,157	NA	NA	-\$2,340	-0.36
Furn. & Birs.	Old	Heating	SIM	Tune B All	Fuel Oil	Fuel Oil	\$500	\$0	56	\$277	NA	NA	\$496	0.89
Furn. & Birs.	Old	Heating	ADM	Furnace C New	Fuel Oil	Fuel Oil	\$452,300	\$102,517	4,301	\$31,987	NA	NA	\$100,074	0.22
Furn. & Birs.	Old	Heating	BAR	Furnace C New	Fuel Oil	Fuel Oil	\$897,100	\$128,863	8,663	\$71,856	NA	NA	\$473,442	0.71
Furn. & Birs.	Old	Heating	COM	Furnace C New	Fuel Oil	Fuel Oil	\$2,900	\$807	13	\$97	NA	NA	\$473,442	0.71
Furn. & Birs.	Old	Heating	ASS	Furnace C New	Fuel Oil	Fuel Oil	\$48,800	\$9,087	704	\$6,238	NA	NA	\$34,566	0.71
Furn. & Birs.	Old	Heating	DGR	Furnace C New	Fuel Oil	Fuel Oil	\$5,800	\$1,614	156	\$1,183	NA	NA	\$12,166	2.10
Furn. & Birs.	Old	Heating	MED	Furnace C New	Fuel Oil	Fuel Oil	\$25,800	\$4,843	388	\$2,893	NA	NA	\$19,731	0.76
Furn. & Birs.	Old	Heating	MES	Furnace C New	Fuel Oil	Fuel Oil	\$31,700	\$15,337	999	\$7,364	NA	NA	\$37,066	0.45
Furn. & Birs.	Old	Heating	OTH	Furnace C New	Fuel Oil	Fuel Oil	\$4,300	\$807	143	\$1,080	NA	NA	\$11,422	2.05
Furn. & Birs.	Old	Heating	REC	Furnace C New	Fuel Oil	Fuel Oil	\$11,800	\$4,036	66	\$480	NA	NA	-\$672	-0.06
Furn. & Birs.	Old	Heating	SHR	Furnace C New	Fuel Oil	Fuel Oil	\$65,900	\$11,301	1,212	\$9,011	NA	NA	\$82,137	1.47
Furn. & Birs.	Old	Heating	WAR	Furnace C New	Fuel Oil	Fuel Oil	\$121,300	\$29,887	855	\$6,361	NA	NA	-\$1,971	-0.02
Furn. & Birs.	Old	Heating	ADM	Furnace S New	Fuel Oil	Fuel Oil	\$290,000	\$102,517	1,773	\$20,342	NA	NA	\$63,836	0.19
Furn. & Birs.	Old	Heating	BAR	Furnace S New	Fuel Oil	Fuel Oil	\$407,800	\$129,963	3,758	\$45,697	NA	NA	\$284,270	0.85
Furn. & Birs.	Old	Heating	COM	Furnace S New	Fuel Oil	Fuel Oil	\$2,000	\$807	5	\$61	NA	NA	-\$463	-0.23
Furn. & Birs.	Old	Heating	ASS	Furnace S New	Fuel Oil	Fuel Oil	\$30,000	\$9,857	274	\$3,331	NA	NA	\$19,208	0.64
Furn. & Birs.	Old	Heating	DGR	Furnace S New	Fuel Oil	Fuel Oil	\$4,000	\$1,614	61	\$739	NA	NA	\$6,368	1.80
Furn. & Birs.	Old	Heating	MED	Furnace S New	Fuel Oil	Fuel Oil	\$15,600	\$4,843	151	\$1,840	NA	NA	\$11,070	0.71
Furn. & Birs.	Old	Heating	MES	Furnace S New	Fuel Oil	Fuel Oil	\$49,400	\$15,337	386	\$4,677	NA	NA	\$21,420	0.43
Furn. & Birs.	Old	Heating	OTH	Furnace S New	Fuel Oil	Fuel Oil	\$2,600	\$807	55	\$674	NA	NA	\$6,208	2.38
Furn. & Birs.	Old	Heating	REC	Furnace S New	Fuel Oil	Fuel Oil	\$8,000	\$4,036	26	\$312	NA	NA	-\$267	-0.03
Furn. & Birs.	Old	Heating	SHR	Furnace S New	Fuel Oil	Fuel Oil	\$33,800	\$11,301	471	\$5,731	NA	NA	\$45,486	1.35
Furn. & Birs.	Old	Heating	WAR	Furnace S New	Fuel Oil	Fuel Oil	\$80,000	\$29,887	333	\$4,045	NA	NA	-\$2,142	-0.03
Furn. & Birs.	Old	Heating	ADM	Boiler P New	Fuel Oil	Fuel Oil	\$136,440	\$14,530	1,243	\$9,992	NA	NA	\$14,384	0.11
Furn. & Birs.	Old	Heating	BAM	Boiler P New	Fuel Oil	Fuel Oil	\$22,740	\$2,422	920	\$7,391	NA	NA	\$80,493	3.54
Furn. & Birs.	Old	Heating	BAR	Boiler P New	Fuel Oil	Fuel Oil	\$88,220	\$7,265	1,027	\$8,258	NA	NA	\$51,681	0.76
Furn. & Birs.	Old	Heating	CLD	Boiler P New	Fuel Oil	Fuel Oil	\$15,180	\$1,614	231	\$1,868	NA	NA	\$11,784	0.78
Furn. & Birs.	Old	Heating	COM	Boiler P New	Fuel Oil	Fuel Oil	\$7,580	\$807	61	\$493	NA	NA	-\$55	-0.01
Furn. & Birs.	Old	Heating	ASS	Boiler P New	Fuel Oil	Fuel Oil	\$37,900	\$4,036	272	\$2,187	NA	NA	-\$4,032	-0.11
Furn. & Birs.	Old	Heating	HOT	Boiler P New	Fuel Oil	Fuel Oil	\$7,580	\$807	94	\$756	NA	NA	\$3,522	0.46
Furn. & Birs.	Old	Heating	MED	Boiler P New	Fuel Oil	Fuel Oil	\$15,180	\$1,614	48	\$392	NA	NA	-\$8,204	-0.54
Furn. & Birs.	Old	Heating	OTH	Boiler P New	Fuel Oil	Fuel Oil	\$37,800	\$4,036	227	\$1,828	NA	NA	-\$8,931	-0.24
Furn. & Birs.	Old	Heating	MTH	Boiler P New	Fuel Oil	Fuel Oil	\$30,320	\$3,229	55	\$444	NA	NA	-\$21,038	-0.89
Furn. & Birs.	Old	Heating	REC	Boiler P New	Fuel Oil	Fuel Oil	\$45,480	\$3,229	980	\$7,954	NA	NA	\$68,246	1.49
Furn. & Birs.	Old	Heating	SHR	Boiler P New	Fuel Oil	Fuel Oil	\$108,120	\$11,301	3,873	\$31,133	NA	NA	\$329,836	3.11
Furn. & Birs.	Old	Heating	WAR	Boiler P New	Fuel Oil	Fuel Oil	\$90,960	\$9,887	550	\$4,421	NA	NA	-\$20,971	-0.23
Furn. & Birs.	Old	Heating	SIM	Boiler P New	Fuel Oil	Fuel Oil	\$103,680	\$1,614	238	\$1,920	NA	NA	\$12,639	0.63
Furn. & Birs.	Old	Heating	ADM	Boiler E New	Fuel Oil	Fuel Oil	\$17,280	\$2,422	368	\$6,688	NA	NA	-\$12,031	-0.12
Furn. & Birs.	Old	Heating	BAM	Boiler E New	Fuel Oil	Fuel Oil	\$17,280	\$2,422	368	\$4,948	NA	NA	\$42,199	2.44
Furn. & Birs.	Old	Heating	BAR	Boiler E New	Fuel Oil	Fuel Oil	\$51,840	\$7,265	411	\$5,527	NA	NA	\$19,158	0.37
Furn. & Birs.	Old	Heating	CLD	Boiler E New	Fuel Oil	Fuel Oil	\$11,520	\$1,614	52	\$1,243	NA	NA	\$4,432	0.38
Furn. & Birs.	Old	Heating	COM	Boiler E New	Fuel Oil	Fuel Oil	\$5,760	\$807	25	\$330	NA	NA	-\$1,152	-0.20
Furn. & Birs.	Old	Heating	ASS	Boiler E New	Fuel Oil	Fuel Oil	\$28,800	\$4,036	109	\$1,464	NA	NA	-\$7,884	-0.27
Furn. & Birs.	Old	Heating	HOT	Boiler E New	Fuel Oil	Fuel Oil	\$5,760	\$807	38	\$506	NA	NA	-\$872	-0.16
Furn. & Birs.	Old	Heating	MED	Boiler E New	Fuel Oil	Fuel Oil	\$11,520	\$1,614	19	\$262	NA	NA	-\$6,863	-0.80
Furn. & Birs.	Old	Heating	OTH	Boiler E New	Fuel Oil	Fuel Oil	\$23,040	\$4,036	91	\$1,223	NA	NA	-\$10,956	-0.37
Furn. & Birs.	Old	Heating	MTH	Boiler E New	Fuel Oil	Fuel Oil	\$3,228	\$3,228	22	\$297	NA	NA	-\$18,392	-0.71
Furn. & Birs.	Old	Heating	REC	Boiler E New	Fuel Oil	Fuel Oil	\$34,560	\$4,843	396	\$6,324	NA	NA	\$31,671	0.92
Furn. & Birs.	Old	Heating	SHR	Boiler E New	Fuel Oil	Fuel Oil	\$80,640	\$11,301	1,549	\$20,832	NA	NA	\$170,940	2.12

TABLE 3.4. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1992 \$)	Present Value of O&M Savings (1992 \$)	Annual Energy Savings (MMBtu)	Value of Annual Energy Savings (1992 \$)	Annual Demand Savings (KW-mo)	Value of Annual Demand Savings (1992 \$)	Net Present Value of ERO (1992 \$)	Value Index
Furn. & Bldg.	Old	Heating	WAR	Boiler E New	Fuel Oil	Nat. Gas (d)	\$89,120	\$9,687	220	\$2,959	NA	NA	-\$26,312	-0.37
Furn. & Bldg.	Old	Heating	SIM	Boiler E New	Fuel Oil	Nat. Gas (d)	\$11,520	\$1,814	98	\$1,285	NA	NA	\$4,910	0.43
Hot Water	Old	Hot Water	MES	New DWH	Propane	Nat. Gas (d)	\$41,540	\$0	268	\$4,525	NA	NA	\$6,338	0.15
Hot Water	Old	Hot Water	WAR	New DWH	Propane	Nat. Gas (d)	\$27,001	\$0	30	\$522	NA	NA	-\$21,472	-0.80
Controls	New	Heating	ADM	Night Sat	Propane	Nat. Gas (d)	\$35,698	\$0	3,907	\$10,781	NA	NA	\$247,322	6.95
Furn. & Bldg.	New	Heating	ASS	Add Pack.	Propane	Nat. Gas (d)	\$5,042	-\$2,451	773	\$3,155	NA	NA	\$40,010	7.94
Furn. & Bldg.	New	Heating	REC	Add Pack.	Propane	Nat. Gas (d)	\$24,128	-\$6,355	1,988	\$7,762	NA	NA	\$73,638	3.05
Trens. & Dist.	New	Heating	LOSS	Line Decomiss.	Propane	Nat. Gas (d)	\$5,130	\$0	3,750	\$15,106	NA	NA	\$266,421	43.30
Trens. & Dist.	New	Heating	LOSS	Pipe Insulation	Propane	Nat. Gas (d)	\$64,000	\$0	10,000	\$42,950	NA	NA	\$89,135	10.31
Trens. & Dist.	New	Heating	LOSS	Lower Temp.	Propane	Nat. Gas (d)	\$0	\$0	39,000	\$187,505	NA	NA	\$2,824,128	(f)
Furn. & Bldg.	On	Heating	HGLE	Furn-C	Fuel Oil	Nat. Gas (d)	\$25,500	\$12,108	280	\$2,409	NA	NA	\$15,866	0.55
Furn. & Bldg.	On	Heating	HGLE	Furn-S	Fuel Oil	Nat. Gas (d)	\$18,750	\$12,108	43	\$1,358	NA	NA	\$6,584	0.35
Hot Water	On	Hot Water	HGLE	New DWH	Fuel Oil	Nat. Gas (d)	\$10,215	\$12,108	28	\$432	NA	NA	\$6,614	0.85
Weather.	On	Heating	HGLE	Window Quilt	Fuel Oil	Nat. Gas (d)	\$11,250	\$0	302	\$1,601	NA	NA	\$14,078	1.25
Weather.	On	Heating	HGLE	Weather. Pack.	Fuel Oil	Nat. Gas (d)	\$1,440	\$0	95	\$323	NA	NA	\$4,012	2.78
Weather.	On	Heating	HGRH	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$22,272	\$0	530	\$2,348	NA	NA	\$18,789	0.88
Weather.	On	Heating	HGRE	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$18,048	\$0	446	\$1,977	NA	NA	\$17,243	0.90
Weather.	On	Heating	HGRE	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$8,544	\$0	253	\$1,121	NA	NA	\$11,528	1.35
Weather.	On	Heating	HGLI	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$20,928	\$0	547	\$2,425	NA	NA	\$22,500	1.08
Weather.	On	Heating	HGLI	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$17,472	\$0	480	\$2,036	NA	NA	\$18,998	1.09
Weather.	On	Heating	HGSL	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$18,048	\$0	410	\$1,818	NA	NA	\$14,475	0.80
Weather.	On	Heating	HGAD	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$18,528	\$0	422	\$1,888	NA	NA	\$14,948	0.81
Weather.	On	Heating	HGSU	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$29,952	\$0	684	\$3,029	NA	NA	\$24,300	0.81
Weather.	On	Heating	HGYO	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$15,552	\$0	365	\$1,673	NA	NA	\$12,817	0.81
Weather.	On	Heating	HGWI	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$7,980	\$0	198	\$889	NA	NA	\$7,882	1.03
Weather.	On	Heating	HGCA	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$14,400	\$0	407	\$1,804	NA	NA	\$17,909	1.24
Weather.	On	Heating	HGPA	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$7,200	\$0	178	\$788	NA	NA	\$6,908	0.98
Weather.	On	Heating	HGSA	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$9,600	\$0	282	\$1,181	NA	NA	\$11,188	1.17
Weather.	On	Heating	HGRH	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$174,000	\$0	2,476	\$10,963	NA	NA	\$22,330	0.13
Weather.	On	Heating	HGRE	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$141,000	\$0	2,076	\$9,198	NA	NA	\$23,891	0.17
Weather.	On	Heating	HGBD	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$85,750	\$0	1,181	\$5,230	NA	NA	\$26,920	0.40
Weather.	On	Heating	HGLI	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$183,500	\$0	2,555	\$11,317	NA	NA	\$39,185	0.24
Weather.	On	Heating	HGCL	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$135,500	\$0	2,145	\$9,503	NA	NA	\$33,682	0.25
Weather.	On	Heating	HGSL	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$141,000	\$0	1,913	\$8,475	NA	NA	\$10,773	0.08
Weather.	On	Heating	HGAD	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$144,750	\$0	1,989	\$8,723	NA	NA	\$11,478	0.08
Weather.	On	Heating	HGSU	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$234,000	\$0	3,181	\$14,137	NA	NA	\$19,175	0.08
Weather.	On	Heating	HGYO	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$121,500	\$0	1,657	\$7,340	NA	NA	\$9,955	0.08
Weather.	On	Heating	HGWI	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$90,000	\$0	915	\$4,055	NA	NA	\$12,822	0.21
Weather.	On	Heating	HGCA	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$112,500	\$0	1,900	\$8,419	NA	NA	\$38,275	0.34
Weather.	On	Heating	HGPA	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$58,250	\$0	830	\$3,678	NA	NA	\$9,578	0.17
Weather.	On	Heating	HGSA	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$75,000	\$0	1,223	\$6,417	NA	NA	\$22,011	0.29
Hot Water	On	Hot Water	HGRH	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$16,778	\$0	223	\$989	NA	NA	\$1,938	0.12
Hot Water	On	Hot Water	HGRE	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$12,784	\$0	187	\$830	NA	NA	\$2,075	0.16
Hot Water	On	Hot Water	HGBD	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$6,052	\$0	107	\$472	NA	NA	\$2,399	0.40
Hot Water	On	Hot Water	HGLI	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$14,824	\$0	230	\$1,021	NA	NA	\$3,462	0.23
Hot Water	On	Hot Water	HGCL	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$12,376	\$0	194	\$857	NA	NA	\$2,979	0.24
Hot Water	On	Hot Water	HGSL	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$12,784	\$0	173	\$785	NA	NA	\$910	0.07
Hot Water	On	Hot Water	HGAD	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$13,124	\$0	178	\$787	NA	NA	\$972	0.07
Hot Water	On	Hot Water	HGSU	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$21,216	\$0	288	\$1,278	NA	NA	\$1,827	0.08
Hot Water	On	Hot Water	HGYO	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$11,016	\$0	149	\$662	NA	NA	\$846	0.08
Hot Water	On	Hot Water	HGWI	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$5,440	\$0	83	\$368	NA	NA	\$1,112	0.20
Hot Water	On	Hot Water	HGCA	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$10,200	\$0	171	\$760	NA	NA	\$3,404	0.33
Hot Water	On	Hot Water	HGPA	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$5,100	\$0	75	\$332	NA	NA	\$1,953	0.16
Hot Water	On	Hot Water	HGSA	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$6,800	\$0	110	\$489	NA	NA	\$1,863	0.28
Weather.	Off	Heating	HGCL	Weather. Pack.	Propane	Propane	\$9,600	\$0	205	\$1,235	NA	NA	\$9,327	0.97

TABLE 3.4. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1992 \$)	Present Value of O&M Savings (1992 \$)	Annual Energy Savings (MBtu)	Value of Annual Energy Savings (1992 \$)	Annual Demand Savings (KW-mo)	Value of Annual Demand Savings (1992 \$)	Net Present Value of ERO (1992 \$)	Value Index
Weather.	Off	Heating	HGCO	Weather. Pack.	Propane	Propane	\$7,200	\$0	127	\$784	NA	NA	\$4,518	0.83
Weather.	Off	Heating	HGCO	Weather. Pack.	Propane	Propane	\$9,218	\$0	184	\$1,110	NA	NA	\$7,798	0.86
Weather.	Off	Heating	HGCO	Weather. Pack.	Propane	Propane	\$7,200	\$0	149	\$888	NA	NA	\$6,862	0.91
Weather.	Off	Heating	HGCO	Weather. Pack.	Propane	Propane	\$5,376	\$0	114	\$685	NA	NA	\$5,119	0.96
Weather.	Off	Heating	HGCO	Window Quilt	Propane	Propane	\$75,000	\$0	958	\$5,781	NA	NA	\$13,325	0.18
Weather.	Off	Heating	HGCO	Window Quilt	Propane	Propane	\$56,250	\$0	593	\$3,667	NA	NA	\$1,567	-0.03
Weather.	Off	Heating	HGCO	Window Quilt	Propane	Propane	\$72,000	\$0	881	\$5,179	NA	NA	\$7,390	0.10
Weather.	Off	Heating	HGCO	Window Quilt	Propane	Propane	\$56,250	\$0	696	\$4,189	NA	NA	\$7,975	0.14
Weather.	Off	Heating	HGCO	Window Quilt	Propane	Propane	\$42,000	\$0	531	\$3,195	NA	NA	\$6,977	0.17
Weather.	Off	Heating	HGCO	Window Quilt	Propane	Propane	\$6,800	\$0	108	\$658	NA	NA	\$3,284	0.48
Hot Water	Off	Hot Water	HGCO	Flue Damper	Propane	Propane	\$5,100	\$0	88	\$408	NA	NA	\$1,149	0.23
Hot Water	Off	Hot Water	HGCO	Flue Damper	Propane	Propane	\$6,528	\$0	98	\$692	NA	NA	\$2,545	0.39
Hot Water	Off	Hot Water	HGCO	Flue Damper	Propane	Propane	\$5,100	\$0	80	\$479	NA	NA	\$2,240	0.44
Hot Water	Off	Hot Water	HGCO	Flue Damper	Propane	Propane	\$3,808	\$0	61	\$365	NA	NA	\$1,789	0.47
Weather.	Off	Heating	HGAC	Weather. Pack.	Nat. Gas (e)	Nat. Gas (e)	\$11,520	\$0	214	\$1,451	NA	NA	\$14,471	1.26
Weather.	Off	Heating	HGAC	Weather. Pack.	Nat. Gas (e)	Nat. Gas (e)	\$24,576	\$0	524	\$3,552	NA	NA	\$39,029	1.58
Weather.	Off	Heating	HGAC	Weather. Pack.	Nat. Gas (e)	Nat. Gas (e)	\$21,504	\$0	420	\$2,860	NA	NA	\$29,528	1.37
Weather.	Off	Heating	HGAC	Weather. Pack.	Nat. Gas (e)	Nat. Gas (e)	\$14,400	\$0	281	\$1,603	NA	NA	\$19,862	1.37
Weather.	Off	Heating	HGAC	Weather. Pack.	Nat. Gas (e)	Nat. Gas (e)	\$14,400	\$0	258	\$1,758	NA	NA	\$17,088	1.18
Weather.	Off	Heating	HGAC	Weather. Pack.	Nat. Gas (e)	Nat. Gas (e)	\$12,096	\$0	304	\$2,061	NA	NA	\$24,819	2.05
Weather.	Off	Heating	HGAC	Weather. Pack.	Nat. Gas (e)	Nat. Gas (e)	\$11,712	\$0	291	\$1,785	NA	NA	\$19,954	1.70
Weather.	Off	Heating	HGAC	Weather. Pack.	Nat. Gas (e)	Nat. Gas (e)	\$28,800	\$0	577	\$3,912	NA	NA	\$41,264	1.43
Weather.	Off	Heating	HGAC	Weather. Pack.	Nat. Gas (e)	Nat. Gas (e)	\$92,000	\$0	989	\$6,773	NA	NA	\$31,292	0.36
Weather.	Off	Heating	HGAC	Window Quilt	Nat. Gas (e)	Nat. Gas (e)	\$190,000	\$0	2,445	\$16,574	NA	NA	\$104,823	0.56
Weather.	Off	Heating	HGAC	Window Quilt	Nat. Gas (e)	Nat. Gas (e)	\$198,000	\$0	1,981	\$13,298	NA	NA	\$70,151	0.42
Weather.	Off	Heating	HGAC	Window Quilt	Nat. Gas (e)	Nat. Gas (e)	\$112,500	\$0	1,310	\$8,881	NA	NA	\$46,548	0.41
Weather.	Off	Heating	HGAC	Window Quilt	Nat. Gas (e)	Nat. Gas (e)	\$112,500	\$0	1,210	\$8,205	NA	NA	\$34,442	0.31
Weather.	Off	Heating	HGAC	Window Quilt	Nat. Gas (e)	Nat. Gas (e)	\$84,500	\$0	1,419	\$9,619	NA	NA	\$77,770	0.82
Weather.	Off	Heating	HGAC	Window Quilt	Nat. Gas (e)	Nat. Gas (e)	\$226,000	\$0	2,693	\$18,257	NA	NA	\$101,984	0.46
Weather.	Off	Heating	HGAC	Window Quilt	Nat. Gas (e)	Nat. Gas (e)	\$8,180	\$0	118	\$797	NA	NA	\$6,121	0.75
Furn. & Bld.	Off	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$17,408	\$0	276	\$1,868	NA	NA	\$16,048	0.92
Furn. & Bld.	Off	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$15,232	\$0	244	\$1,652	NA	NA	\$14,348	0.94
Furn. & Bld.	Off	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$10,200	\$0	163	\$1,102	NA	NA	\$9,538	0.94
Furn. & Bld.	Off	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$10,200	\$0	160	\$1,018	NA	NA	\$8,036	0.78
Furn. & Bld.	Off	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$8,588	\$0	136	\$825	NA	NA	\$8,001	0.93
Furn. & Bld.	Off	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$8,298	\$0	127	\$860	NA	NA	\$7,113	0.88
Furn. & Bld.	Off	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$20,400	\$0	317	\$2,150	NA	NA	\$18,098	0.89
Lighting	Off	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$19,890	\$134	113	\$1,759	70.8	\$390	\$10,492	0.53
Lighting	Off	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$5,943	\$4,314	74	\$988	59.4	\$327	\$16,892	2.84
Lighting	Off	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$156,926	\$70,487	708	\$10,478	627.3	\$3,466	\$109,888	0.70
Lighting	Off	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$18,757	\$46,201	348	\$4,656	279.8	\$1,541	\$113,689	6.06
Lighting	Off	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$21,482	\$32,970	237	\$3,680	201.7	\$1,111	\$78,678	3.87
Lighting	On	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$81,736	\$73,530	508	\$7,522	450.3	\$2,481	\$132,607	1.82
Lighting	On	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$227,018	\$198,298	1,328	\$19,657	1,176.8	\$6,484	\$339,270	1.49
Lighting	On	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$62,505	\$54,598	366	\$9,848	0.0	\$0	\$127,873	2.05
Lighting	Off	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$62,282	\$37,608	287	\$7,041	0.0	\$0	\$74,464	1.20
Lighting	Off	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$37,920	\$83,808	697	\$10,862	437.3	\$2,410	\$232,514	6.13
Lighting	Off	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$2,584	\$3,294	25	\$383	21.1	\$116	\$7,738	2.89
Lighting	Off	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$69,199	\$41,796	297	\$7,826	0.0	\$0	\$82,751	1.20
Lighting	Off	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$11,474	\$20,807	142	\$3,734	0.0	\$0	\$81,895	5.39
Lighting	Off	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$38,481	\$43,866	333	\$8,785	0.0	\$0	\$129,048	3.35
Lighting	Off	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$511,036	\$602,500	4,597	\$65,034	4,072.8	\$22,441	\$1,266,079	2.48
Lighting	On	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$636,305	\$816,549	4,723	\$89,897	4,184.4	\$23,068	\$1,288,740	2.03
Lighting	On	Heating	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$446,471	\$432,688	3,319	\$87,543	0.0	\$0	\$1,218,455	2.73

TABLE 3.4. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed (1992 \$)	Present Value of O&M Savings (1992 \$)	Annual Energy Savings (MBtu)	Value of Annual Energy Savings (1992 \$)	Annual Demand (KW-mo)	Value of Annual Demand Savings (1992 \$)	Net Present Value of ERO (1992 \$)	Value Index
Lighting	Old/New	Inc 2X60 Cell (a)	D	Retro All	Elect.	Elect.	\$5,641	\$11,928	108	\$1,632	67.8	\$374	\$34,528	6.12
Lighting	Old/New	Inc 2X60 Cell (a)	A	Retro All	Elect.	Elect.	\$234,419	\$230,276	1,743	\$26,791	1,544.0	\$8,507	\$478,676	2.04
Lighting	On	Inc 2X60 Cell (a)	G	Retro All	Elect.	Elect.	\$91,637	\$96,087	870	\$9,823	694.0	\$3,273	\$180,304	2.08
Lighting	Old/New	Inc 200 Supp (a)	B	Retro All	Elect.	Elect.	\$59,496	\$10,383	677	\$8,889	490.3	\$2,702	\$87,446	1.47
Lighting	Old/New	Inc 160 Supp (a)	B	Retro All	Elect.	Elect.	\$121,871	\$84,908	958	\$14,740	812.1	\$4,476	\$63,808	0.52
Lighting	On	Inc 160 Cell (a)	G	Retro All	Elect.	Elect.	\$31,368	\$2,520	257	\$4,241	253.9	\$1,389	\$50,060	1.57
Lighting	Old/New	Inc 160 Cell (a)	A	Retro All	Elect.	Elect.	\$5,218	\$396	47	\$686	41.6	\$229	\$8,177	1.57
Lighting	Old/New	Inc 100 Supp (a)	B	Retro All	Elect.	Elect.	\$1,608	\$-793	12	\$189	10.4	\$67	\$1,173	0.76
Lighting	Off	Inc 100 Cell (a)	E	Retro All	Elect.	Elect.	\$172,637	\$77,511	1,178	\$31,026	0.0	\$0	\$341,617	1.98
Lighting	Old/New	Inc 100 Cell (a)	A	Retro All	Elect.	Elect.	\$8,708	\$3,910	58	\$878	52.6	\$290	\$11,641	1.34
Lighting	Old/New	HPS 400 Ext (a)	B	Retro All	Elect.	Elect.	\$17,475	\$38,868	1,508	\$20,050	1,040.1	\$5,731	\$384,118	21.98
Lighting	Old/New	HPS 100 Wall Ext (a)	B	Retro All	Elect.	Elect.	\$20,775	\$42,142	502	\$6,664	345.7	\$1,905	\$141,991	6.83
Lighting	Off	FL 5X4 2-40 Std (a)	E	Retro All	Elect.	Elect.	\$21,246	\$19,409	311	\$8,206	0.0	\$0	\$43,867	0.46
Lighting	Old/New	FL 5X4 2-40 Std (a)	B	Retro All	Elect.	Elect.	\$25,680	\$8,219	120	\$1,850	101.9	\$562	\$14,488	0.56
Lighting	On	FL 5X4 1-40 Std (a)	G	Retro All	Elect.	Elect.	\$0	\$0	0	\$0	0.0	\$0	\$0	(c)
Lighting	Old/New	FL 5X4 1-40 Std (a)	C	Retro All	Elect.	Elect.	\$92,891	\$15,467	454	\$7,077	284.9	\$1,670	\$74,188	1.18
Lighting	Old/New	FL 5X4 1-34 Std (a)	B	Retro All	Elect.	Elect.	\$3,400	\$1,215	12	\$188	10.3	\$67	\$1,290	0.37
Lighting	Old/New	FL 5X4 1-34 Std (a)	A	Retro All	Elect.	Elect.	\$0	\$0	0	\$0	0.0	\$0	\$0	(c)
Lighting	Old/New	FL 2X4 6-40 Std (a)	B	Retro All	Elect.	Elect.	\$30,456	\$82,293	1,800	\$27,746	1,528.7	\$8,423	\$500,888	5.54
Lighting	Old/New	FL 2X4 6-40 Std (a)	B	Retro Sensor	Elect.	Elect.	\$36,780	\$30,046	648	\$9,879	567.4	\$3,128	\$178,369	4.90
Lighting	Old/New	FL 2X4 6-40 Std (b)	B	Retro Sensor	Elect.	Elect.	\$59,108	\$63,775	1,178	\$18,131	998.9	\$6,504	\$327,372	6.54
Lighting	Old/New	FL 2X4 6-40 Std (a)	B	Sensor	Elect.	Elect.	\$59,108	\$63,775	1,178	\$18,131	998.9	\$6,504	\$327,372	6.54
Lighting	Old/New	FL 2X4 6-40 Std (b)	B	Sensor	Elect.	Elect.	\$5,413	\$8,188	111	\$1,689	170.0	\$937	\$37,756	0.97
Lighting	On	FL 2X4 6-40 Std (b)	B	Sensor	Elect.	Elect.	\$9,796	\$2,897	100	\$1,477	88.4	\$487	\$20,767	2.12
Lighting	Off	FL 2X4 4-40 Std (a)	G	Retro All	Elect.	Elect.	\$30,732	\$6,967	213	\$5,616	0.0	\$0	\$55,280	1.90
Lighting	On	FL 2X4 4-40 Std (a)	E	Retro All	Elect.	Elect.	\$91,172	\$64,138	1,883	\$30,921	1,246.2	\$10,861	\$504,882	5.84
Lighting	Old/New	FL 2X4 4-40 Std (a)	C	Retro All	Elect.	Elect.	\$88	\$287	8	\$134	8.0	\$44	\$1,882	2.12
Lighting	Old/New	FL 2X4 4-40 Std (a)	A	Retro All	Elect.	Elect.	\$19,873	\$13,639	252	\$3,805	168.0	\$871	\$59,689	3.00
Lighting	Old/New	FL 2X4 4-34 Std (a)	D	Retro Sensor	Elect.	Elect.	\$23,884	\$15,576	278	\$4,180	174.8	\$962	\$83,822	2.87
Lighting	Old/New	FL 2X4 4-34 Std (b)	D	Retro Sensor	Elect.	Elect.	\$3,981	\$3,388	59	\$882	40.3	\$222	\$14,931	3.74
Lighting	Old/New	FL 2X4 4-34 Std (b)	D	Sensor	Elect.	Elect.	\$627,024	\$381,531	8,482	\$130,459	7,187.8	\$39,605	\$2,148,489	3.43
Lighting	Old/New	FL 2X4 4-34 Std (a)	B	Retro All	Elect.	Elect.	\$618,271	\$376,205	8,344	\$128,638	7,087.4	\$39,062	\$2,118,498	3.43
Lighting	Old/New	FL 2X4 4-34 Std (a)	B	Retro Sensor	Elect.	Elect.	\$11,609	\$6,485	134	\$2,050	126.4	\$691	\$33,468	2.88
Lighting	Old/New	FL 2X4 4-34 Std (b)	B	Retro Sensor	Elect.	Elect.	\$618,271	\$376,205	8,344	\$128,638	7,087.4	\$39,062	\$2,118,498	3.43
Lighting	Old/New	FL 2X4 4-34 Std (a)	B	Sensor	Elect.	Elect.	\$2,856	\$1,997	33	\$498	50.2	\$276	\$10,049	3.52
Lighting	Old/New	FL 2X4 4-34 Std (b)	B	Sensor	Elect.	Elect.	\$410,800	\$138,801	3,373	\$49,921	2,988.5	\$16,466	\$862,733	1.81
Lighting	Old/New	FL 2X4 4-34 Std (a)	A	Retro All	Elect.	Elect.	\$0	\$0	0	\$0	0.0	\$0	\$0	(c)
Lighting	Old/New	FL 2X4 4-34 Std (a)	A	Retro Sensor	Elect.	Elect.	\$0	\$0	0	\$0	0.0	\$0	\$0	(c)
Lighting	Old/New	FL 2X4 3-40 Std (b)	A	Retro Sensor	Elect.	Elect.	\$0	\$0	0	\$0	0.0	\$0	\$0	(c)
Lighting	Old/New	FL 2X4 3-40 Std (a)	A	Sensor	Elect.	Elect.	\$784	\$172	3	\$49	3.6	\$19	\$347	0.44
Lighting	Old/New	FL 2X4 3-40 Std (b)	A	Sensor	Elect.	Elect.	\$117,026	\$38,900	654	\$9,873	410.1	\$2,259	\$90,858	0.77
Lighting	Old/New	FL 2X4 3-34 Std (a)	D	Retro All	Elect.	Elect.	\$26,816	\$8,456	160	\$2,262	94.0	\$518	\$20,773	0.77
Lighting	Old/New	FL 2X4 3-34 Std (a)	D	Retro Sensor	Elect.	Elect.	\$98,189	\$34,253	578	\$8,684	386.8	\$2,018	\$86,678	0.88
Lighting	Old/New	FL 2X4 3-34 Std (b)	D	Retro Sensor	Elect.	Elect.	\$26,816	\$8,456	160	\$2,262	94.0	\$518	\$20,773	0.77
Lighting	Old/New	FL 2X4 3-34 Std (b)	D	Sensor	Elect.	Elect.	\$7,979	\$8,200	141	\$2,126	97.1	\$535	\$17,679	0.72
Lighting	Old/New	FL 2X4 3-34 Std (b)	D	Sensor	Elect.	Elect.	\$1,101,800	\$298,951	3,853	\$59,394	3,272.3	\$18,031	\$284,948	0.28
Lighting	Old/New	FL 2X4 3-34 Std (a)	B	Retro All	Elect.	Elect.	\$284,480	\$71,252	925	\$14,258	786.4	\$4,328	\$68,395	0.28
Lighting	Old/New	FL 2X4 3-34 Std (a)	B	Retro Sensor	Elect.	Elect.	\$912,461	\$264,567	3,489	\$52,710	3,300.8	\$18,187	\$340,122	0.37
Lighting	Old/New	FL 2X4 3-34 Std (b)	B	Retro Sensor	Elect.	Elect.	\$76,121	\$67,936	938	\$14,266	1,436.6	\$7,910	\$294,972	3.93
Lighting	Old/New	FL 2X4 3-34 Std (b)	B	Sensor	Elect.	Elect.	\$284,480	\$71,252	925	\$14,258	786.4	\$4,328	\$68,395	0.28
Lighting	Old/New	FL 2X4 2-40 Std (a)	A	Retro All	Elect.	Elect.	\$9,072	\$4,184	34	\$511	21.2	\$117	\$3,929	0.43
Lighting	Old/New	FL 2X4 2-34 Std (a)	D	Retro All	Elect.	Elect.	\$0	\$0	0	\$0	0.0	\$0	\$0	(c)
Lighting	Old/New	FL 2X4 2-34 Std (a)	B	Retro All	Elect.	Elect.	\$0	\$0	0	\$0	0.0	\$0	\$0	(c)
Lighting	Old/New	FL 2X4 2-34 Std (a)	A	Retro All	Elect.	Elect.	\$0	\$0	0	\$0	0.0	\$0	\$0	(c)

TABLE 3.4. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1992 \$)	Present Value of O&M Savings (1992 \$)	Annual Energy Savings (MMBtu)	Value of Annual Energy Savings (1992 \$)	Annual Demand Savings (KW-mo)	Value of Annual Demand Savings (1992 \$)	Net Present Value of ERO (1992 \$)	Value Index
Lighting	Old/New	FL 2X4 2-34 Std (b)	A	Retro&Sensor	Elect.	Elect.	\$0	\$0	0	\$0	0.0	\$0	\$0	(c)
Lighting	Old/New	FL 2X4 2-34 Std (a)	A	Retro&Sensor	Elect.	Elect.	\$0	\$0	0	\$0	0.0	\$0	\$0	(c)
Lighting	Old/New	FL 2X4 2-34 Std (b)	A	Sensor	Elect.	Elect.	\$17,907	\$8,211	110	\$1,828	0.0	\$0	\$22,836	1.29
Lighting	Old/New	FL 2X4 2-34 Std (b)	A	Sensor	Elect.	Elect.	\$67,470	\$18,186	300	\$4,818	264.5	\$1,402	\$46,482	0.79
Lighting	Old/New	FL 1X8 2-36 Std (a)	B	Retro All	Elect.	Elect.	\$0	\$0	0	\$0	0.0	\$0	\$0	(c)
Lighting	Old/New	FL 1X4 2-40 Std (a)	G	Retro All	Elect.	Elect.	\$240,240	\$58,178	1,123	\$17,308	953.5	\$5,254	\$135,518	0.58
Lighting	Old/New	FL 1X4 2-40 Std (a)	B	Retro All	Elect.	Elect.	\$179,760	\$43,632	840	\$12,960	713.5	\$3,931	\$101,401	0.58
Lighting	Old/New	FL 1X4 2-40 Std (a)	B	Retro&Sensor	Elect.	Elect.	\$76,018	\$16,274	304	\$4,838	273.4	\$1,508	\$26,766	0.36
Lighting	Old/New	FL 1X4 2-40 Std (b)	B	Retro&Sensor	Elect.	Elect.	\$179,760	\$43,632	840	\$12,960	713.5	\$3,931	\$101,401	0.58
Lighting	Old/New	FL 1X4 2-40 Std (a)	B	Sensor	Elect.	Elect.	\$15,538	\$3,403	61	\$928	93.4	\$614	\$8,182	0.53
Lighting	Old/New	FL 1X4 2-40 Std (b)	B	Sensor	Elect.	Elect.	\$0	\$0	0	\$0	0.0	\$0	\$0	(c)
Lighting	Old/New	FL 1X4 2-40 Std (b)	A	Retro All	Elect.	Elect.	\$185,372	\$58,686	863	\$14,540	603.9	\$3,328	\$124,834	0.67
Lighting	Old/New	FL 1X4 2-34 Std WP (a)	D	Retro All	Elect.	Elect.	\$44,407	\$14,068	231	\$3,483	144.7	\$797	\$29,906	0.67
Lighting	Old/New	FL 1X4 2-34 Std WP (a)	D	Retro&Sensor	Elect.	Elect.	\$148,846	\$63,347	808	\$12,176	511.3	\$2,817	\$116,441	0.78
Lighting	Old/New	FL 1X4 2-34 Std WP (b)	D	Retro&Sensor	Elect.	Elect.	\$7,980	\$11,989	178	\$2,847	120.9	\$686	\$60,630	6.34
Lighting	Old/New	FL 1X4 2-34 Std WP (b)	D	Sensor	Elect.	Elect.	\$44,407	\$14,068	231	\$3,483	144.7	\$797	\$29,906	0.67
Lighting	Old/New	FL 1X4 2-34 Std WP (a)	D	Sensor	Elect.	Elect.	\$68,842	\$28,378	200	\$3,078	169.6	\$834	\$26,978	0.44
Lighting	Old/New	FL 1X4 2-34 Std (a)	B	Retro All	Elect.	Elect.	\$49,014	\$23,636	186	\$2,562	141.2	\$778	\$21,638	0.44
Lighting	Old/New	FL 1X4 2-34 Std (a)	B	Retro&Sensor	Elect.	Elect.	\$13,801	\$6,873	51	\$781	66.2	\$309	\$7,422	0.64
Lighting	Old/New	FL 1X4 2-34 Std (b)	B	Retro&Sensor	Elect.	Elect.	\$3,973	\$1,648	23	\$347	34.9	\$193	\$6,272	1.33
Lighting	Old/New	FL 1X4 2-34 Std (a)	B	Sensor	Elect.	Elect.	\$49,014	\$23,636	186	\$2,562	141.2	\$778	\$21,638	0.44
Lighting	Old/New	FL 1X4 2-34 Std (a)	A	Retro All	Elect.	Elect.	\$0	\$0	0	\$0	0.0	\$0	\$0	(c)
Lighting	Old/New	FL 1X4 2-34 Std (a)	A	Retro&Sensor	Elect.	Elect.	\$0	\$0	0	\$0	0.0	\$0	\$0	(c)
Lighting	Old/New	FL 1X4 2-34 Std (b)	A	Retro&Sensor	Elect.	Elect.	\$7,047	\$3,286	44	\$651	47.2	\$280	\$9,080	1.29
Lighting	Old/New	FL 1X4 2-34 Std (b)	A	Sensor	Elect.	Elect.	\$0	\$0	0	\$0	0.0	\$0	\$0	(c)
Lighting	Old/New	FL 1X4 1-40 Std (a)	C	Retro All	Elect.	Elect.	\$90,666	\$23,711	686	\$10,849	436.8	\$2,407	\$113,744	1.18
Lighting	Old/New	FL 1X4 1-40 Std (a)	B	Retro All	Elect.	Elect.	\$844	\$314	4	\$66	3.0	\$17	\$377	0.40
Lighting	Old/New	FL 1X4 1-40 Std (a)	A	Retro All	Elect.	Elect.	\$0	\$0	0	\$0	0.0	\$0	\$0	(c)
Lighting	Old/New	Exit 2XPL9 (a)	A	Retro All	Elect.	Elect.	\$70,000	\$123,872	314	\$4,581	126.0	\$694	\$128,128	1.83
Lighting	Old/New	Exit 2X20 (a)	D	Retro All	Elect.	Elect.	\$18,060	\$80,712	136	\$1,970	64.2	\$299	\$84,680	5.24
Lighting	Old/New	Exit 2X20 (a)	B	Retro All	Elect.	Elect.	\$89,040	\$397,928	666	\$9,711	287.1	\$1,472	\$486,306	6.24
Lighting	Old/New	Exit 2X20 (a)	B	Retro All	Elect.	Elect.	\$226,120	\$1,006,078	1,982	\$24,552	876.4	\$3,721	\$1,178,980	6.24
Lighting	Old/New	Exit 2X15 (a)	C	Retro All	Elect.	Elect.	\$7,140	\$31,909	38	\$566	16.3	\$84	\$33,788	4.73
Lighting	Old/New	Exit 2X15 (a)	B	Retro All	Elect.	Elect.	\$121,380	\$542,468	648	\$9,468	280.1	\$1,433	\$674,368	4.73
Lighting	Old/New	6a FL 2X4 4-34 STD (b)	B	Sensor	Elect.	Elect.	\$11,084	\$20,336	268	\$4,261	155	\$851	\$81,223	7.33
Lighting	Old/New	6b FL 2X4 4-34 STD (b)	B	Sensor	Elect.	Elect.	\$30,166	\$20,626	268	\$4,113	155	\$851	\$60,262	2.00
Lighting	Old/New	6c FL 2X4 4-34 STD (b)	B	Sensor	Elect.	Elect.	\$127,160	\$170,182	2,198	\$37,738	1,773	\$9,768	\$711,741	6.60
Lighting	Old/New	6d FL 2X4 4-34 STD (b)	B	Sensor	Elect.	Elect.	\$30,433	\$24,578	299	\$4,870	158	\$858	\$71,988	2.37
Lighting	Old/New	6e FL 2X4 4-34 STD (b)	A,B	Sensor	Elect.	Elect.	\$2,040	\$3,329	38	\$626	28	\$157	\$12,291	6.02
Lighting	Old/New	6f FL 2X4 4-34 STD (b)	B	Sensor	Elect.	Elect.	\$3,908	\$7,644	91	\$1,565	80	\$439	\$31,905	8.38
Lighting	Old/New	6g FL 2X4 4-34 STD (b)	D	Sensor	Elect.	Elect.	\$4,568	\$11,918	131	\$2,243	102	\$583	\$46,883	10.28
Lighting	Old/New	6h FL 2X4 4-34 STD (b)	A,B	Sensor	Elect.	Elect.	\$14,820	\$28,694	314	\$5,399	248	\$1,364	\$109,131	7.46
Lighting	Old/New	6i FL 2X4 4-34 STD (b)	A,B	Sensor	Elect.	Elect.	\$31,824	\$41,624	460	\$7,836	357	\$1,965	\$147,768	4.64
Lighting	Old/New	6j FL 2X4 4-34 STD (b)	D	Sensor	Elect.	Elect.	\$4,440	\$1,515	18	\$274	9	\$60	\$1,639	0.37
Lighting	Old/New	7a FL 2X4 2-34 STD (b)	A,D	Sensor	Elect.	Elect.	\$5,168	\$4,888	48	\$791	36	\$198	\$13,664	2.64
Lighting	Old/New	7b FL 2X4 2-34 STD (b)	A,B	Sensor	Elect.	Elect.	\$29,230	\$14,424	143	\$2,243	76	\$413	\$22,677	0.77
Lighting	Old/New	7c FL 2X4 2-34 STD (b)	A,D	Sensor	Elect.	Elect.	\$1,632	\$771	7	\$125	6	\$31	\$1,340	0.82
Lighting	Old/New	INC 2X60 CEIL (b)	A	Sensor	Elect.	Elect.	\$1,480	\$2,081	11	\$173	6	\$32	\$3,476	2.36
Lighting	Old/New	6a FL 2X4 4-34 STD (b)	B	Retro & Sensor	Elect.	Elect.	\$44,338	\$49,617	634	\$10,867	427	\$2,366	\$188,463	4.26
Lighting	Old/New	6b FL 2X4 4-34 STD (b)	B	Retro & Sensor	Elect.	Elect.	\$44,338	\$49,617	634	\$10,867	427	\$2,366	\$188,463	4.26
Lighting	Old/New	6c FL 2X4 4-34 STD (b)	B	Retro & Sensor	Elect.	Elect.	\$508,840	\$259,636	3,681	\$63,211	4,903	\$27,016	\$1,021,127	2.01
Lighting	Old/New	6d FL 2X4 4-34 STD (b)	B	Retro & Sensor	Elect.	Elect.	\$44,744	\$33,984	442	\$7,079	431	\$2,377	\$122,364	2.73
Lighting	Old/New	6e FL 2X4 4-34 STD (b)	A,B	Retro & Sensor	Elect.	Elect.	\$5,160	\$3,972	55	\$962	79	\$433	\$15,311	1.88

TABLE 3.4. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1982 \$)	Present Value of O&M Savings (1982 \$)	Annual Energy Savings (MMBtu)	Value of Annual Energy Savings (1982 \$)	Annual Demand Savings (KW-mo)	Value of Annual Demand Savings (1982 \$)	Net Present Value of ERO (1992 \$)	Value Index
Lighting	Old/New	5f FL 2X4 4-34 STD (b)	B	Retro & Sensor	Elect.	Elect.	\$20,844	\$11,663	157	\$2,699	220	\$1,214	\$45,802	2.19
Lighting	Old/New	6a FL 2X4 3-34 STD (b)	D	Retro & Sensor	Elect.	Elect.	\$48,096	\$14,711	187	\$3,217	252	\$1,387	\$33,419	0.72
Lighting	Old/New	6b FL 2X4 3-34 STD (b)	A,B	Retro & Sensor	Elect.	Elect.	\$114,595	\$35,405	451	\$7,742	608	\$3,337	\$76,776	0.87
Lighting	Old/New	6c FL 2X4 3-34 STD (b)	A,B	Retro & Sensor	Elect.	Elect.	\$176,904	\$51,378	654	\$11,235	879	\$4,943	\$100,809	0.67
Lighting	Old/New	6d FL 2X4 3-34 STD (b)	D	Retro & Sensor	Elect.	Elect.	\$5,352	\$2,054	24	\$391	23	\$124	\$3,953	0.74
Lighting	Old/New	7a FL 2X4 2-34 STD (b)	A,D	Retro & Sensor	Elect.	Elect.	\$20,872	\$5,889	53	\$918	55	\$304	\$2,394	0.12
Lighting	Old/New	7b FL 2X4 2-34 STD (b)	A,B	Retro & Sensor	Elect.	Elect.	\$42,978	\$18,969	164	\$2,591	115	\$532	\$21,396	0.60
Lighting	Old/New	7c FL 2X4 2-34 STD (b)	A,D	Retro & Sensor	Elect.	Elect.	\$4,080	\$930	8	\$145	9	\$48	\$438	-0.11
Lighting	Old/New	INC 2X80 CEIL (b)	A	Retro & Sensor	Elect.	Elect.	\$1,600	\$1,040	18	\$286	19	\$103	\$4,916	3.07
Pumps/Motors	New	1 AHU Fan	ADM	Effic.-RI	Elect.	Elect.	\$17,841	\$1,826	32	\$465	59.1	\$326	\$6,087	-0.29
Pumps/Motors	New	1 AHU Fan	ADM	Effic.-ROF	Elect.	Elect.	\$10,400	\$1,048	32	\$254	59.1	\$178	\$3,194	0.31
Pumps/Motors	New	11 HW Pumps	ADM	Effic.-RI	Elect.	Elect.	\$37,960	\$3,332	58	\$658	94.5	\$521	\$16,213	-0.40
Pumps/Motors	New	11 HW Pumps	ADM	Effic.-ROF	Elect.	Elect.	\$22,122	\$2,358	59	\$489	94.5	\$285	\$5,041	0.23
Pumps/Motors	New	2 AHU Fan	ADM	Effic.-RI	Elect.	Elect.	\$17,841	\$1,826	40	\$681	59.1	\$326	\$3,451	-0.19
Pumps/Motors	New	2 AHU Fan	ADM	Effic.-ROF	Elect.	Elect.	\$10,400	\$1,048	40	\$318	59.1	\$178	\$3,818	0.37
Pumps/Motors	New	10 Prim Pump	ASS	2-SPD-RI	Elect.	Elect.	\$2,552	\$882	35	\$505	-23.9	-\$132	\$1,804	0.71
Pumps/Motors	New	10 Prim Pump	ASS	2-SPD-ROF	Elect.	Elect.	\$1,488	\$812	35	\$278	-23.9	-\$72	\$1,089	0.73
Pumps/Motors	New	10 Prim Pump	ASS	Effic.-RI	Elect.	Elect.	\$1,462	\$108	3	\$49	12.2	\$67	\$294	0.20
Pumps/Motors	New	10 Prim Pump	ASS	Effic.-ROF	Elect.	Elect.	\$846	\$108	3	\$27	12.2	\$37	\$616	0.61
Pumps/Motors	New	11 Sec. Pump	ASS	2-SPD-RI	Elect.	Elect.	\$2,552	\$882	5	\$91	-6.0	-\$33	\$2,822	-1.03
Pumps/Motors	New	11 Sec. Pump	ASS	2-SPD-ROF	Elect.	Elect.	\$1,488	\$812	5	\$50	-6.0	-\$18	\$699	-0.40
Pumps/Motors	New	11 Sec. Pump	ASS	Effic.-RI	Elect.	F. act.	\$1,462	\$108	1	\$9	3.1	\$17	\$978	-0.87
Pumps/Motors	New	11 Sec. Pump	ASS	Effic.-ROF	Elect.	L. act.	\$846	\$108	1	\$5	3.1	\$9	\$30	0.04
Pumps/Motors	New	7 Return Fan	ASS	2-SPD-RI	Elect.	Elect.	\$8,556	\$1,887	145	\$2,112	-10.9	-\$60	\$20,148	2.84
Pumps/Motors	New	7 Return Fan	ASS	2-SPD-ROF	Elect.	Elect.	\$3,997	\$2,190	145	\$1,164	-10.9	-\$33	\$8,828	2.21
Pumps/Motors	New	7 Return Fan	ASS	Effic.-RI	Elect.	Elect.	\$4,160	\$301	11	\$155	9.4	\$62	\$948	-0.23
Pumps/Motors	New	7 Return Fan	ASS	Effic.-ROF	Elect.	Elect.	\$2,425	\$323	11	\$85	9.4	\$28	\$788	0.32
Pumps/Motors	New	8 AHU Fan	ASS	2-SPD-RI	Elect.	Elect.	\$3,426	\$867	78	\$1,137	-16.4	-\$90	\$10,345	3.02
Pumps/Motors	New	8 AHU Fan	ASS	2-SPD-ROF	Elect.	Elect.	\$1,998	\$1,119	78	\$622	-16.4	-\$49	\$4,503	2.25
Pumps/Motors	New	8 AHU Fan	ASS	Effic.-RI	Elect.	Elect.	\$2,080	\$127	6	\$84	14.1	\$78	\$316	0.15
Pumps/Motors	New	8 AHU Fan	ASS	Effic.-ROF	Elect.	Elect.	\$1,213	\$186	6	\$48	14.1	\$42	\$590	0.56
Pumps/Motors	New	8 AHU Fan	ASS	2-SPD-RI	Elect.	Elect.	\$2,633	\$885	118	\$1,089	-24.3	-\$134	\$16,385	3.65
Pumps/Motors	New	8 AHU Fan	ASS	2-SPD-ROF	Elect.	Elect.	\$1,300	\$1,300	118	\$923	-24.3	-\$73	\$7,047	2.68
Pumps/Motors	New	9 AHU Fan	ASS	2-SPD-RI	Elect.	Elect.	\$2,982	\$175	9	\$131	20.8	\$115	\$639	0.21
Pumps/Motors	New	9 AHU Fan	ASS	Effic.-RI	Elect.	Elect.	\$1,744	\$274	8	\$72	20.8	\$63	\$1,044	0.80
Pumps/Motors	New	9 AHU Fan	ASS	Effic.-ROF	Elect.	Elect.	\$2,315	\$231	40	\$588	64.8	\$358	\$9,280	-0.37
Pumps/Motors	New	3 Supply Fan	BAR	Effic.-RI	Elect.	Elect.	\$14,494	\$1,414	40	\$321	64.8	\$186	\$3,684	0.25
Pumps/Motors	New	3 Supply Fan	BAR	Effic.-ROF	Elect.	Elect.	\$2,796	\$9,370	587	\$10,083	-188.3	-\$1,038	\$91,172	3.40
Pumps/Motors	New	4 AHU-5,6	BAR	2-SPD-RI	Elect.	Elect.	\$15,620	\$9,680	587	\$5,510	-188.3	-\$567	\$38,980	2.50
Pumps/Motors	New	4 AHU-5,6	BAR	2-SPD-ROF	Elect.	Elect.	\$15,248	\$1,138	57	\$982	98.0	\$529	\$7,159	0.47
Pumps/Motors	New	4 AHU-5,6	BAR	Effic.-RI	Elect.	Elect.	\$8,887	\$1,149	57	\$537	98.0	\$289	\$6,982	0.78
Pumps/Motors	New	4 AHU-5,6	BAR	Effic.-ROF	Elect.	Elect.	\$40,194	\$14,055	1,258	\$18,339	-282.4	-\$1,558	\$182,004	4.53
Pumps/Motors	New	5 AHU-1,2,3	BAR	2-SPD-RI	Elect.	Elect.	\$23,430	\$14,370	1,258	\$10,022	-282.4	-\$860	\$76,726	3.23
Pumps/Motors	New	5 AHU-1,2,3	BAR	2-SPD-ROF	Elect.	Elect.	\$22,869	\$1,708	123	\$1,788	144.1	\$794	\$16,152	0.86
Pumps/Motors	New	5 AHU-1,2,3	BAR	Effic.-RI	Elect.	Elect.	\$13,331	\$1,723	123	\$976	144.1	\$434	\$12,126	0.91
Pumps/Motors	New	5 AHU-1,2,3	BAR	Effic.-ROF	Elect.	Elect.	\$13,398	\$4,686	419	\$6,111	-94.2	\$519	\$80,638	4.63
Pumps/Motors	New	6 AHU-4	BAR	2-SPD-RI	Elect.	Elect.	\$7,810	\$4,790	419	\$3,340	-94.2	-\$284	\$26,230	3.23
Pumps/Motors	New	6 AHU-4	BAR	2-SPD-ROF	Elect.	Elect.	\$7,623	\$669	41	\$593	48.0	\$264	\$5,023	0.68
Pumps/Motors	New	6 AHU-4	BAR	Effic.-RI	Elect.	Elect.	\$4,444	\$574	41	\$324	48.0	\$145	\$4,031	0.91
Pumps/Motors	New	6 AHU-4	BAR	Effic.-ROF	Elect.	Elect.	\$24,591	\$8,982	280	\$4,224	-35.5	-\$186	\$23,129	0.89
Pumps/Motors	New	7 Sup Wtr Pmp	BAR	2-SPD-RI	Elect.	Elect.	\$14,335	\$8,882	290	\$2,308	-35.5	-\$107	\$12,782	0.94
Pumps/Motors	New	7 Sup Wtr Pmp	BAR	2-SPD-ROF	Elect.	Elect.	\$13,860	\$1,217	36	\$622	23.0	\$127	\$3,609	-0.25
Pumps/Motors	New	7 Sup Wtr Pmp	BAR	Effic.-RI	Elect.	Elect.	\$13,860	\$862	36	\$285	23.0	\$69	\$2,622	0.32
Pumps/Motors	New	7 Sup Wtr Pmp	BAR	Effic.-ROF	Elect.	Elect.	\$29,798	\$9,370	689	\$10,188	-83.7	-\$481	\$100,763	3.76
Pumps/Motors	New	8 Sup Wtr Pmp	BAR	2-SPD-RI	Elect.	Elect.	\$15,620	\$9,580	689	\$5,588	-83.7	-\$252	\$42,638	2.73

TABLE 3.4. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1992 \$)	Present Value of O&M Savings (1992 \$)	Annual Energy Savings (MMBtu)	Value of Annual Energy Savings (1992 \$)	Annual Demand Savings (KW-mo)	Value of Annual Demand Savings (1992 \$)	Net Present Value of ERO (1992 \$)	Value Index
Pump/Motors	New	8 Sup Wtr Pmp	BAR	Effic.-RI	Elect.	Elect.	\$15,240	\$1,138	68	\$892	42.7	\$236	\$3,189	0.21
Pump/Motors	New	8 Sup Wtr Pmp	BAR	Effic.-ROF	Elect.	Elect.	\$8,887	\$1,149	68	\$542	42.7	\$128	\$5,440	0.61
Pump/Motors	New	18 Ref Comp	CLB	Effic.-RI	Elect.	Elect.	\$2,817	\$257	6	\$73	3.1	\$17	\$1,286	-0.46
Pump/Motors	New	18 Ref Comp	CLB	Effic.-ROF	Elect.	Elect.	\$1,842	\$106	6	\$40	3.1	\$8	\$320	0.19
Pump/Motors	New	19 Pump	CLB	Effic.-RI	Elect.	Elect.	\$888	\$83	1	\$19	0.8	\$4	\$475	-0.63
Pump/Motors	New	19 Pump	CLB	Effic.-ROF	Elect.	Elect.	\$618	\$60	1	\$10	0.8	\$2	\$76	0.15
Pump/Motors	New	21 AC Comp.	CLB	Effic.-RI	Elect.	Elect.	\$1,776	\$165	1	\$20	1.5	\$5	\$1,210	-0.68
Pump/Motors	New	21 AC Comp.	CLB	Effic.-ROF	Elect.	Elect.	\$1,035	\$101	1	\$11	1.5	\$5	\$52	0.05
Pump/Motors	Old	21 AC Comp.	CLB	Effic.-RI	Elect.	Elect.	\$888	\$83	1	\$10	0.8	\$4	\$697	-0.67
Pump/Motors	Old	1 Chiller Cond	CLNIC	Effic.-RI	Elect.	Elect.	\$618	\$60	1	\$18	0.8	\$2	\$29	0.08
Pump/Motors	Old	1 Chiller Cond	CLNIC	Effic.-ROF	Elect.	Elect.	\$883	\$57	6	\$76	2.7	\$15	\$336	0.34
Pump/Motors	Old	10 Vac Pump	CLNIC	Effic.-RI	Elect.	Elect.	\$673	\$80	6	\$41	2.7	\$8	\$391	0.80
Pump/Motors	Old	10 Vac Pump	CLNIC	Effic.-ROF	Elect.	Elect.	\$448	\$448	27	\$457	-9.0	-\$50	\$4,017	3.15
Pump/Motors	Old	11 EXH Fan	CLNIC	2-SPD-RI	Elect.	Elect.	\$744	\$458	27	\$250	-9.0	-\$27	\$1,732	2.33
Pump/Motors	Old	11 EXH Fan	CLNIC	2-SPD-ROF	Elect.	Elect.	\$726	\$54	3	\$45	4.6	\$25	\$312	0.43
Pump/Motors	Old	11 EXH Fan	CLNIC	Effic.-RI	Elect.	Elect.	\$656	\$64	3	\$24	4.6	\$14	\$320	0.76
Pump/Motors	Old	11 EXH Fan	CLNIC	Effic.-ROF	Elect.	Elect.	\$423	\$423	48	\$897	-4.2	-\$23	\$7,627	6.03
Pump/Motors	Old	12 HTHW Pump	CLNIC	2-SPD-RI	Elect.	Elect.	\$873	\$508	48	\$381	-4.2	-\$13	\$3,110	3.58
Pump/Motors	Old	12 HTHW Pump	CLNIC	Effic.-RI	Elect.	Elect.	\$918	\$46	4	\$66	4.0	\$22	\$348	0.38
Pump/Motors	Old	12 HTHW Pump	CLNIC	Effic.-ROF	Elect.	Elect.	\$635	\$82	4	\$35	4.0	\$12	\$374	0.70
Pump/Motors	Old	12 HTHW Pump	CLNIC	Effic.-RI	Elect.	Elect.	\$1,276	\$448	13	\$211	-3.0	-\$17	\$1,021	0.80
Pump/Motors	Old	2 Chill Supply	CLNIC	2-SPD-RI	Elect.	Elect.	\$744	\$456	13	\$116	-3.0	-\$8	\$580	0.79
Pump/Motors	Old	2 Chill Supply	CLNIC	2-SPD-ROF	Elect.	Elect.	\$726	\$54	1	\$21	1.5	\$8	\$266	-0.37
Pump/Motors	Old	2 Chill Supply	CLNIC	Effic.-RI	Elect.	Elect.	\$64	\$64	1	\$11	1.5	\$8	\$100	0.24
Pump/Motors	Old	2 Chill Supply	CLNIC	Effic.-ROF	Elect.	Elect.	\$423	\$423	6	\$80	1.5	\$10	\$185	0.32
Pump/Motors	Old	4 AHU Fan	CLNIC	2-SPD-RI	Elect.	Elect.	\$586	\$214	6	\$11	-1.5	-\$10	\$185	0.48
Pump/Motors	Old	4 AHU Fan	CLNIC	Effic.-RI	Elect.	Elect.	\$342	\$211	6	\$44	-1.5	-\$8	\$185	0.48
Pump/Motors	Old	4 AHU Fan	CLNIC	2-SPD-ROF	Elect.	Elect.	\$330	\$29	1	\$10	1.2	\$7	\$68	-0.21
Pump/Motors	Old	4 AHU Fan	CLNIC	Effic.-RI	Elect.	Elect.	\$192	\$21	1	\$5	1.2	\$4	\$68	0.36
Pump/Motors	Old	4 AHU Fan	CLNIC	Effic.-ROF	Elect.	Elect.	\$638	\$223	13	\$194	-4.5	-\$25	\$1,521	2.38
Pump/Motors	Old	5 AHU Fan	CLNIC	2-SPD-RI	Elect.	Elect.	\$372	\$228	13	\$108	-4.5	-\$14	\$680	1.83
Pump/Motors	Old	5 AHU Fan	CLNIC	2-SPD-ROF	Elect.	Elect.	\$363	\$27	1	\$19	2.2	\$12	\$101	0.28
Pump/Motors	Old	5 AHU Fan	CLNIC	Effic.-RI	Elect.	Elect.	\$212	\$27	1	\$10	2.2	\$7	\$139	0.66
Pump/Motors	Old	5 AHU Fan	CLNIC	Effic.-ROF	Elect.	Elect.	\$1,714	\$484	56	\$812	-8.2	-\$45	\$8,603	6.02
Pump/Motors	Old	6 AHU Fan	CLNIC	2-SPD-RI	Elect.	Elect.	\$989	\$659	56	\$444	-8.2	-\$25	\$3,560	3.66
Pump/Motors	Old	6 AHU Fan	CLNIC	2-SPD-ROF	Elect.	Elect.	\$1,040	\$63	4	\$80	7.1	\$39	\$414	0.40
Pump/Motors	Old	6 AHU Fan	CLNIC	Effic.-RI	Elect.	Elect.	\$806	\$83	4	\$33	7.1	\$21	\$438	0.72
Pump/Motors	Old	6 AHU Fan	CLNIC	Effic.-ROF	Elect.	Elect.	\$868	\$61	2	\$32	2.3	\$13	\$189	-0.22
Pump/Motors	Old	7 Chiller Comp	CLNIC	Effic.-RI	Elect.	Elect.	\$508	\$79	2	\$17	2.3	\$7	\$161	0.32
Pump/Motors	Old	7 Chiller Comp	CLNIC	Effic.-ROF	Elect.	Elect.	\$2,180	\$133	6	\$80	6.3	\$35	\$440	-0.20
Pump/Motors	Old	8 Chiller Comp	CLNIC	Effic.-RI	Elect.	Elect.	\$1,277	\$198	5	\$44	6.3	\$19	\$421	0.33
Pump/Motors	Old	8 Chiller Comp	CLNIC	Effic.-ROF	Elect.	Elect.	\$818	\$48	4	\$52	2.1	\$6	\$12	0.02
Pump/Motors	Old	9 Vac Pump	CLNIC	Effic.-RI	Elect.	Elect.	\$536	\$92	4	\$28	2.1	\$6	\$248	0.46
Pump/Motors	Old	9 Vac Pump	CLNIC	Effic.-ROF	Elect.	Elect.	\$2,571	\$726	77	\$1,127	-4.1	-\$23	\$12,256	4.77
Pump/Motors	New	1 Chill Pump	DGR	2-SPD-RI	Elect.	Elect.	\$1,489	\$839	77	\$816	-4.1	-\$12	\$5,092	3.40
Pump/Motors	New	1 Chill Pump	DGR	2-SPD-ROF	Elect.	Elect.	\$909	\$85	6	\$45	3.6	\$11	\$28	-0.02
Pump/Motors	New	1 Chill Pump	DGR	Effic.-RI	Elect.	Elect.	\$1,38	\$138	6	\$45	3.6	\$11	\$409	0.46
Pump/Motors	New	2 Chiller	DGR	Effic.-ROF	Elect.	Elect.	\$4,497	\$289	19	\$278	11.8	\$66	\$572	0.13
Pump/Motors	New	2 Chiller	DGR	Effic.-RI	Elect.	Elect.	\$6,021	\$406	19	\$151	11.8	\$36	\$1,425	0.54
Pump/Motors	New	3 Chiller	DGR	Effic.-ROF	Elect.	Elect.	\$2,412	\$337	23	\$331	14.0	\$77	\$673	0.12
Pump/Motors	New	3 Chiller	DGR	Effic.-RI	Elect.	Elect.	\$3,165	\$476	23	\$181	14.0	\$42	\$1,717	0.64
Pump/Motors	New	4 AHU Fan	DGR	2-SPD-RI	Elect.	Elect.	\$638	\$223	27	\$388	-4.5	-\$25	\$4,254	6.67
Pump/Motors	New	4 AHU Fan	DGR	2-SPD-ROF	Elect.	Elect.	\$372	\$228	27	\$212	-4.5	-\$14	\$1,722	4.63
Pump/Motors	New	4 AHU Fan	DGR	Effic.-RI	Elect.	Elect.	\$363	\$27	3	\$38	2.2	\$7	\$367	1.01
Pump/Motors	New	4 AHU Fan	DGR	Effic.-ROF	Elect.	Elect.	\$212	\$27	3	\$21	2.2	\$7	\$241	1.14
Pump/Motors	New	5 AHU Fan	DGR	2-SPD-RI	Elect.	Elect.	\$748	\$232	38	\$568	3.1	\$17	\$6,631	8.87

TABLE 3.4. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1992 \$)	Present Value of O&M Savings (1992 \$)	Annual Energy Savings (MBtu)	Value of Annual Energy Savings (1992 \$)	Annual Demand Savings (KW-mo)	Value of Annual Demand Savings (1992 \$)	Net Present Value of ERO (1992 \$)	Value Index
Pump/Motors	New	5 AHU Fan	DGR	2-SPD-ROF	Elect.	Elect.	\$436	-4264	38	\$305	-3.1	-49	\$2,849	6.07
Pump/Motors	New	5 AHU Fan	DGR	Effic.-RI	Elect.	Elect.	\$458	\$23	4	\$2	3.0	\$17	\$525	1.14
Pump/Motors	New	5 AHU Fan	DGR	Effic.-ROF	Elect.	Elect.	\$468	-446	4	\$28	3.0	\$9	\$321	1.20
Pump/Motors	New	6 AHU Fan	DGR	2-SPD-ROF	Elect.	Elect.	\$857	-4242	58	\$812	-4.1	-12	\$10,020	11.89
Pump/Motors	New	6 AHU Fan	DGR	2-SPD-ROF	Elect.	Elect.	\$857	-4242	58	\$812	-4.1	-12	\$3,981	7.93
Pump/Motors	New	6 AHU Fan	DGR	Effic.-RI	Elect.	Elect.	\$520	\$32	4	\$80	3.5	\$19	\$823	1.20
Pump/Motors	New	6 AHU Fan	DGR	Effic.-ROF	Elect.	Elect.	\$303	-446	4	\$33	3.5	\$11	\$378	1.26
Pump/Motors	New	7 HTHW Pump	DGR	2-SPD-ROF	Elect.	Elect.	\$2,571	-4725	167	\$2,437	-8.2	-46	\$30,379	11.82
Pump/Motors	New	7 HTHW Pump	DGR	2-SPD-ROF	Elect.	Elect.	\$1,489	-4839	167	\$1,332	-8.2	-26	\$12,003	8.01
Pump/Motors	New	7 HTHW Pump	DGR	Effic.-RI	Elect.	Elect.	\$1,560	\$95	12	\$179	7.1	\$39	\$1,808	1.03
Pump/Motors	New	7 HTHW Pump	DGR	Effic.-ROF	Elect.	Elect.	\$908	-4139	12	\$98	7.1	\$21	\$1,032	1.14
Pump/Motors	New	8 Dom Wtr Htr	DGR	Effic.-RI	Elect.	Elect.	\$459	\$23	4	\$52	4.0	\$22	\$802	1.31
Pump/Motors	New	8 Dom Wtr Htr	DGR	Effic.-ROF	Elect.	Elect.	\$288	-446	4	\$28	4.0	\$12	\$350	1.31
Pump/Motors	New	9 Cond Fan Ch	DGR	Effic.-RI	Elect.	Elect.	\$6,512	\$808	7	\$105	5.8	\$31	-3,893	-0.81
Pump/Motors	New	9 Cond Fan Ch	DGR	Effic.-ROF	Elect.	Elect.	\$3,786	-4370	7	\$57	5.8	\$17	\$359	0.08
Pump/Motors	New	1 Ref Comp	GRO	Effic.-RI	Elect.	Elect.	\$12,480	\$761	59	\$858	37.6	\$207	\$3,289	0.28
Pump/Motors	New	1 Ref Comp	GRO	Effic.-ROF	Elect.	Elect.	\$7,275	-4111	59	\$499	37.6	\$113	\$4,905	0.63
Pump/Motors	New	2 AHU Fan	GRO	2-SPD-ROF	Elect.	Elect.	\$748	-4232	24	\$349	-3.1	-17	\$3,887	4.83
Pump/Motors	New	2 AHU Fan	GRO	Effic.-RI	Elect.	Elect.	\$436	-4264	24	\$191	-3.1	-49	\$1,528	3.50
Pump/Motors	New	2 AHU Fan	GRO	Effic.-ROF	Elect.	Elect.	\$458	\$23	2	\$32	3.0	\$17	\$252	0.55
Pump/Motors	New	2 AHU Fan	GRO	Effic.-RI	Elect.	Elect.	\$288	-446	2	\$18	3.0	\$9	\$216	0.81
Pump/Motors	New	3 AHU Fan	GRO	2-SPD-ROF	Elect.	Elect.	\$1,878	-4300	101	\$1,878	-11.8	-86	\$19,079	11.73
Pump/Motors	New	3 AHU Fan	GRO	Effic.-RI	Elect.	Elect.	\$1,095	-488	6	\$100	9.5	\$52	\$7,798	7.97
Pump/Motors	New	3 AHU Fan	GRO	Effic.-ROF	Elect.	Elect.	\$638	-4461	6	\$55	9.5	\$29	\$1,119	1.02
Pump/Motors	New	3 AHU Fan	GRO	Effic.-RI	Elect.	Elect.	\$3,256	\$303	3	\$44	5.8	\$31	-1,903	-0.58
Pump/Motors	New	1 HW Pump	MED	Effic.-ROF	Elect.	Elect.	\$1,888	-4185	3	\$24	5.8	\$17	\$216	0.11
Pump/Motors	New	10 SF2	MED	2-SPD-ROF	Elect.	Elect.	\$1,497	-4465	28	\$418	-6.2	-34	\$3,448	2.30
Pump/Motors	New	10 SF2	MED	Effic.-RI	Elect.	Elect.	\$873	-4508	29	\$229	-6.2	-19	\$1,554	1.78
Pump/Motors	New	10 SF2	MED	Effic.-ROF	Elect.	Elect.	\$918	\$48	3	\$39	8.1	\$34	\$147	0.18
Pump/Motors	New	11 AHU Fan	MED	2-SPD-ROF	Elect.	Elect.	\$636	-492	3	\$21	8.1	\$18	\$297	0.58
Pump/Motors	New	11 AHU Fan	MED	Effic.-RI	Elect.	Elect.	\$7,889	-1,585	131	\$2,083	-48.2	-208	\$16,085	2.04
Pump/Motors	New	11 AHU Fan	MED	2-SPD-ROF	Elect.	Elect.	\$4,605	-42,225	131	\$1,133	-48.2	-145	\$7,529	1.64
Pump/Motors	New	11 AHU Fan	MED	Effic.-RI	Elect.	Elect.	\$5,208	\$308	10	\$153	40.7	\$224	\$415	0.08
Pump/Motors	New	11 AHU Fan	MED	Effic.-ROF	Elect.	Elect.	\$3,038	-4473	10	\$94	40.7	\$123	\$1,554	0.51
Pump/Motors	New	12 Return Fan	MED	2-SPD-ROF	Elect.	Elect.	\$1,278	-4448	17	\$243	-3.0	-17	\$1,460	1.14
Pump/Motors	New	12 Return Fan	MED	Effic.-RI	Elect.	Elect.	\$744	-4456	17	\$133	-3.0	-49	\$757	1.02
Pump/Motors	New	12 Return Fan	MED	Effic.-ROF	Elect.	Elect.	\$728	\$54	2	\$24	1.5	\$8	-223	-0.31
Pump/Motors	New	12 Return Fan	MED	Effic.-RI	Elect.	Elect.	\$423	-455	2	\$13	1.5	\$6	\$118	0.28
Pump/Motors	New	13 Chill Pump	MED	2-SPD-ROF	Elect.	Elect.	\$2,928	-1,070	14	\$219	-3.2	-18	-1,163	-0.40
Pump/Motors	New	13 Chill Pump	MED	Effic.-RI	Elect.	Elect.	\$1,707	-1,055	14	\$120	-3.2	-10	\$28	0.02
Pump/Motors	New	13 Chill Pump	MED	Effic.-ROF	Elect.	Elect.	\$1,650	\$145	2	\$27	2.0	\$11	-989	-0.59
Pump/Motors	New	13 Chill Pump	MED	Effic.-RI	Elect.	Elect.	\$962	-1,03	2	\$15	2.0	\$8	\$102	0.11
Pump/Motors	New	14 Wtr Pmp Cond	MED	2-SPD-ROF	Elect.	Elect.	\$1,914	-4889	25	\$384	-9.0	-50	\$1,841	0.96
Pump/Motors	New	14 Wtr Pmp Cond	MED	Effic.-RI	Elect.	Elect.	\$1,118	-4684	25	\$199	-9.0	-27	\$1,003	0.90
Pump/Motors	New	14 Wtr Pmp Cond	MED	Effic.-ROF	Elect.	Elect.	\$1,089	\$81	2	\$35	4.6	\$25	-152	-0.14
Pump/Motors	New	14 Wtr Pmp Cond	MED	Effic.-RI	Elect.	Elect.	\$635	-482	2	\$19	4.6	\$14	\$244	0.38
Pump/Motors	New	16 Supply Pmp	MED	2-SPD-ROF	Elect.	Elect.	\$1,712	-4649	12	\$178	-5.5	-30	-308	-0.18
Pump/Motors	New	16 Supply Pmp	MED	Effic.-RI	Elect.	Elect.	\$998	-4633	12	\$86	-5.5	-17	\$150	0.15
Pump/Motors	New	16 Supply Pmp	MED	Effic.-ROF	Elect.	Elect.	\$948	\$79	2	\$25	4.1	\$12	-194	-0.20
Pump/Motors	New	16 Supply Pmp	MED	Effic.-RI	Elect.	Elect.	\$553	-463	2	\$4	4.1	\$12	\$194	0.35
Pump/Motors	New	17 Air Comp	MED	Effic.-ROF	Elect.	Elect.	\$1,377	\$69	1	\$21	3.0	\$17	-778	-0.56
Pump/Motors	New	17 Air Comp	MED	Effic.-RI	Elect.	Elect.	\$803	-4137	1	\$12	3.0	\$9	\$85	0.08
Pump/Motors	New	18 Air Comp	MED	Effic.-ROF	Elect.	Elect.	\$2,804	\$154	3	\$48	6.8	\$37	-1,249	-0.48
Pump/Motors	New	18 Air Comp	MED	Effic.-RI	Elect.	Elect.	\$1,518	-4237	3	\$26	6.8	\$20	\$221	0.15

TABLE 3.4. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1992 \$)	Present Value of O&M Savings (1992 \$)	Annual Energy Savings (MBtu)	Value of Annual Energy Savings (1992 \$)	Annual Demand Savings (KW-mo)	Value of Annual Demand Savings (1992 \$)	Net Present Value of ERO (1992 \$)	Value Index
Pump/Motors	New	19 AHU Fan	MED	2-SPD-RI	Elect.	Elect.	\$1,276	-4449	20	\$291	-9.0	-180	\$1,877	1.31
Pump/Motors	New	19 AHU Fan	MED	2-SPD-ROF	Elect.	Elect.	\$744	-9480	20	\$159	-9.0	-427	\$940	1.13
Pump/Motors	New	19 AHU Fan	MED	Effic.-RI	Elect.	Elect.	\$726	\$54	2	\$28	4.6	\$25	\$84	0.12
Pump/Motors	New	19 AHU Fan	MED	Effic.-ROF	Elect.	Elect.	\$726	-856	2	\$16	4.6	\$14	\$234	0.86
Pump/Motors	New	2 Air Comp	MED	Effic.-RI	Elect.	Elect.	\$8,784	\$789	4	\$92	3.2	\$10	-6,842	-0.78
Pump/Motors	New	2 Air Comp	MED	Effic.-ROF	Elect.	Elect.	\$8,784	-1515	4	\$34	3.2	\$10	-187	-0.02
Pump/Motors	New	20 AHU Fan	MED	2-SPD-RI	Elect.	Elect.	\$1,497	-4466	29	\$458	-6.2	-434	\$3,971	2.85
Pump/Motors	New	20 AHU Fan	MED	2-SPD-ROF	Elect.	Elect.	\$873	-8508	29	\$248	-6.2	-419	\$1,754	2.01
Pump/Motors	New	20 AHU Fan	MED	Effic.-RI	Elect.	Elect.	\$818	\$48	3	\$42	6.1	\$34	\$196	0.21
Pump/Motors	New	20 AHU Fan	MED	Effic.-ROF	Elect.	Elect.	\$818	-992	3	\$23	6.1	\$18	\$316	0.89
Pump/Motors	New	3 Vac Pump	MED	Effic.-RI	Elect.	Elect.	\$1,896	\$168	2	\$28	4.1	\$23	-1,031	-0.84
Pump/Motors	New	3 Vac Pump	MED	Effic.-ROF	Elect.	Elect.	\$1,106	-1126	2	\$16	4.1	\$12	\$143	0.13
Pump/Motors	New	4 Vac Pump	MED	Effic.-RI	Elect.	Elect.	\$3,120	\$180	3	\$49	7.1	\$39	-1,093	-0.64
Pump/Motors	New	4 Vac Pump	MED	Effic.-ROF	Elect.	Elect.	\$1,819	-4278	3	\$27	7.1	\$21	\$194	0.11
Pump/Motors	New	5 Vac Pump	MED	Effic.-RI	Elect.	Elect.	\$9,548	\$564	11	\$153	24.9	\$137	-44,985	-0.61
Pump/Motors	New	5 Vac Pump	MED	Effic.-ROF	Elect.	Elect.	\$5,566	-8588	11	\$84	24.9	\$76	\$891	0.12
Pump/Motors	New	6 Wtr Tr Pump	MED	Effic.-RI	Elect.	Elect.	\$16,711	\$968	19	\$277	47.2	\$200	-8,181	-0.49
Pump/Motors	New	6 Wtr Tr Pump	MED	Effic.-ROF	Elect.	Elect.	\$9,741	-11,538	19	\$151	47.2	\$142	\$1,346	0.14
Pump/Motors	New	8 Booster EXH	MED	2-SPD-RI	Elect.	Elect.	\$5,142	-11,451	84	\$1,327	-16.4	-690	\$10,819	2.10
Pump/Motors	New	8 Booster EXH	MED	2-SPD-ROF	Elect.	Elect.	\$2,897	-11,678	84	\$725	-16.4	-449	\$4,992	1.66
Pump/Motors	New	8 Booster EXH	MED	Effic.-RI	Elect.	Elect.	\$3,120	\$190	6	\$97	14.1	\$78	-1464	-0.15
Pump/Motors	New	8 Booster EXH	MED	Effic.-ROF	Elect.	Elect.	\$1,819	-2278	6	\$53	14.1	\$42	\$663	0.38
Pump/Motors	New	18 Ref Comp	MES	Effic.-RI	Elect.	Elect.	\$6,573	\$689	12	\$171	7.3	\$40	-12,997	-0.46
Pump/Motors	New	18 Ref Comp	MES	Effic.-ROF	Elect.	Elect.	\$3,832	-4387	12	\$94	7.3	\$22	\$748	0.20
Pump/Motors	New	19 Pump	MES	Effic.-RI	Elect.	Elect.	\$2,072	\$183	3	\$45	1.8	\$10	-1,112	-0.54
Pump/Motors	New	19 Pump	MES	Effic.-ROF	Elect.	Elect.	\$1,208	-1118	3	\$24	1.8	\$5	\$176	0.14
Pump/Motors	New	21 AC Comp.	MES	Effic.-RI	Elect.	Elect.	\$4,144	\$386	3	\$47	3.6	\$20	-42,813	-0.68
Pump/Motors	New	21 AC Comp.	MES	Effic.-ROF	Elect.	Elect.	\$2,416	-2236	3	\$26	3.6	\$11	\$125	0.06
Pump/Motors	New	2 Return Fan	REC	2-SPD-RI	Elect.	Elect.	\$2,664	-11,729	81	\$1,176	-7.4	-441	\$9,078	2.12
Pump/Motors	New	2 Return Fan	REC	2-SPD-ROF	Elect.	Elect.	\$2,664	-11,088	81	\$642	-7.4	-422	\$4,403	1.05
Pump/Motors	New	2 Return Fan	REC	Effic.-RI	Elect.	Elect.	\$2,528	\$211	12	\$109	5.4	\$30	\$482	0.19
Pump/Motors	New	2 Return Fan	REC	Effic.-ROF	Elect.	Elect.	\$1,474	-1168	12	\$92	5.4	\$16	\$989	0.81
Pump/Motors	New	3 Return Fan	REC	2-SPD-RI	Elect.	Elect.	\$5,104	-11,785	133	\$1,941	-12.0	-469	\$19,499	3.92
Pump/Motors	New	3 Return Fan	REC	2-SPD-ROF	Elect.	Elect.	\$2,976	-11,825	133	\$1,061	-12.0	-436	\$8,238	2.77
Pump/Motors	New	3 Return Fan	REC	Effic.-RI	Elect.	Elect.	\$2,904	\$217	13	\$189	6.1	\$34	\$446	0.16
Pump/Motors	New	3 Return Fan	REC	Effic.-ROF	Elect.	Elect.	\$1,693	-4219	13	\$103	6.1	\$18	\$978	0.68
Pump/Motors	New	4 AHU Fan	REC	2-SPD-RI	Elect.	Elect.	\$5,986	-11,960	210	\$3,098	-24.8	-137	\$33,417	5.58
Pump/Motors	New	4 AHU Fan	REC	2-SPD-ROF	Elect.	Elect.	\$3,498	-12,032	210	\$1,677	-24.8	-175	\$13,704	3.93
Pump/Motors	New	4 AHU Fan	REC	Effic.-RI	Elect.	Elect.	\$3,672	\$185	20	\$294	24.2	\$133	\$2,394	0.95
Pump/Motors	New	4 AHU Fan	REC	Effic.-ROF	Elect.	Elect.	\$2,141	-4366	20	\$155	24.2	\$73	\$1,877	0.88
Pump/Motors	New	5 AHU Fan	REC	2-SPD-RI	Elect.	Elect.	\$6,856	-11,934	307	\$4,469	-32.7	-180	\$51,578	7.62
Pump/Motors	New	5 AHU Fan	REC	2-SPD-ROF	Elect.	Elect.	\$3,897	-12,237	307	\$2,442	-32.7	-188	\$20,786	5.20
Pump/Motors	New	5 AHU Fan	REC	Effic.-RI	Elect.	Elect.	\$4,190	\$264	23	\$328	28.2	\$155	\$2,901	0.70
Pump/Motors	New	5 AHU Fan	REC	Effic.-ROF	Elect.	Elect.	\$2,426	-4370	23	\$179	28.2	\$85	\$2,226	0.92
Pump/Motors	New	6 HTHW Pump	REC	2-SPD-RI	Elect.	Elect.	\$10,208	-43,568	320	\$4,658	-47.8	-243	\$48,079	4.71
Pump/Motors	New	6 HTHW Pump	REC	2-SPD-ROF	Elect.	Elect.	\$5,951	-43,660	320	\$2,546	-47.8	-144	\$18,538	3.36
Pump/Motors	New	6 HTHW Pump	REC	Effic.-RI	Elect.	Elect.	\$5,808	\$433	31	\$454	24.4	\$134	\$2,902	0.50
Pump/Motors	New	6 HTHW Pump	REC	Effic.-ROF	Elect.	Elect.	\$3,388	-4438	31	\$248	24.4	\$73	\$2,719	0.80
Pump/Motors	New	7 EXH Fan	REC	2-SPD-RI	Elect.	Elect.	\$13,122	-44,971	186	\$3,185	-63.8	-352	\$21,793	1.66
Pump/Motors	New	7 EXH Fan	REC	2-SPD-ROF	Elect.	Elect.	\$4,863	-44,863	186	\$1,741	-63.8	-192	\$10,367	1.36
Pump/Motors	New	7 EXH Fan	REC	Effic.-RI	Elect.	Elect.	\$7,268	\$606	27	\$458	47.2	\$280	\$3,449	0.47
Pump/Motors	New	7 EXH Fan	REC	Effic.-ROF	Elect.	Elect.	\$4,237	-4484	27	\$250	47.2	\$142	\$3,372	0.80
Pump/Motors	New	8 Supply Fan	REC	2-SPD-RI	Elect.	Elect.	\$4,564	-11,729	81	\$1,176	-22.2	-122	\$8,530	1.87
Pump/Motors	New	8 Supply Fan	REC	2-SPD-ROF	Elect.	Elect.	\$2,661	-11,088	81	\$642	-22.2	-122	\$3,966	1.49
Pump/Motors	New	8 Supply Fan	REC	Effic.-RI	Elect.	Elect.	\$2,628	\$211	12	\$169	16.4	\$80	\$1,335	0.53

TABLE 3.4. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1992 \$)	Present Value of O&M Savings (1992 \$)	Annual Savings (MBtu)	Value of Annual Energy Savings (1992 \$)	Annual Demand Savings (KW-mo)	Value of Annual Demand Savings (1992 \$)	Net Present Value of EPO (1992 \$)	Value Index
Pumps/Motors	New	8 Supply Fan	REC	Effic.-ROF	Elect.	Elect.	\$1,474	-\$168	12	\$82	16.4	\$49	\$1,224	0.83
Pumps/Motors	Old	1 Lift Pump Motor	SEWER	Effic.-RI	Elect.	Elect.	\$1,368	\$20	14	\$214	7.0	\$39	\$2,220	1.62
Pumps/Motors	Old	1 Lift Pump Motor	SEWER	Effic.-ROF	Elect.	Elect.	\$1,260	-\$758	14	\$197	7.0	\$35	\$2,332	1.86
Pumps/Motors	Old	10 Lift Pump Motor	SEWER	2-SPD-RI	Elect.	Elect.	\$840	-\$235	0	\$4	0.1	\$1	-\$1,014	-1.21
Pumps/Motors	Old	10 Lift Pump Motor	SEWER	2-SPD-ROF	Elect.	Elect.	\$480	-\$270	0	\$2	0.1	\$0	-\$247	-0.50
Pumps/Motors	Old	10 Lift Pump Motor	SEWER	Effic.-RI	Elect.	Elect.	\$521	\$32	0	\$1	0.1	\$1	-\$471	-0.90
Pumps/Motors	Old	10 Lift Pump Motor	SEWER	Effic.-ROF	Elect.	Elect.	\$304	-\$446	0	\$0	0.1	\$0	-\$439	-0.13
Pumps/Motors	Old	11 Lift Pump Motor	SEWER	2-SPD-RI	Elect.	Elect.	\$701	-\$225	5	\$81	0.5	\$3	-\$22	-0.03
Pumps/Motors	Old	11 Lift Pump Motor	SEWER	2-SPD-ROF	Elect.	Elect.	\$409	-\$238	5	\$34	0.5	\$2	\$106	0.26
Pumps/Motors	Old	11 Lift Pump Motor	SEWER	Effic.-RI	Elect.	Elect.	\$422	\$27	1	\$11	0.4	\$2	-\$214	-0.51
Pumps/Motors	Old	11 Lift Pump Motor	SEWER	Effic.-ROF	Elect.	Elect.	\$246	-\$36	1	\$6	0.4	\$1	\$33	0.13
Pumps/Motors	Old	2 Lift Pump Motor	SEWER	2-SPD-RI	Elect.	Elect.	\$701	-\$225	2	\$27	0.4	\$2	-\$508	-0.73
Pumps/Motors	Old	2 Lift Pump Motor	SEWER	2-SPD-ROF	Elect.	Elect.	\$409	-\$238	2	\$15	0.4	\$1	-\$80	-0.20
Pumps/Motors	Old	2 Lift Pump Motor	SEWER	Effic.-RI	Elect.	Elect.	\$422	\$27	0	\$5	0.2	\$1	-\$313	-0.74
Pumps/Motors	Old	2 Lift Pump Motor	SEWER	Effic.-ROF	Elect.	Elect.	\$246	-\$36	0	\$3	0.2	\$1	-\$5	-0.02
Pumps/Motors	Old	3 Lift Pump Motor	SEWER	2-SPD-RI	Elect.	Elect.	\$840	-\$235	2	\$26	0.3	\$2	-\$683	-0.82
Pumps/Motors	Old	3 Lift Pump Motor	SEWER	2-SPD-ROF	Elect.	Elect.	\$490	-\$270	2	\$14	0.3	\$1	-\$124	-0.25
Pumps/Motors	Old	3 Lift Pump Motor	SEWER	Effic.-RI	Elect.	Elect.	\$521	\$32	0	\$6	0.2	\$1	-\$400	-0.77
Pumps/Motors	Old	3 Lift Pump Motor	SEWER	Effic.-ROF	Elect.	Elect.	\$304	-\$446	0	\$3	0.2	\$1	-\$12	-0.04
Pumps/Motors	Old	4 Lift Pump Motor	SEWER	2-SPD-RI	Elect.	Elect.	\$3,369	-\$465	80	\$1,085	13.1	\$72	\$9,458	1.49
Pumps/Motors	New	4 Lift Pump Motor	SEWER	2-SPD-ROF	Elect.	Elect.	\$3,713	-\$1,329	80	\$693	13.1	\$39	\$4,884	1.32
Pumps/Motors	New	4 Lift Pump Motor	SEWER	Downsize-RI	Elect.	Elect.	\$867	\$860	117	\$1,729	65.1	\$359	\$29,385	33.89
Pumps/Motors	New	4 Lift Pump Motor	SEWER	Downsize-ROF	Elect.	Elect.	\$806	\$1,280	117	\$845	65.1	\$168	\$12,488	24.71
Pumps/Motors	New	4 Lift Pump Motor	SEWER	Effic.-RI	Elect.	Elect.	\$738	-\$298	7	\$104	4.0	\$22	-\$2,693	-0.66
Pumps/Motors	New	4 Lift Pump Motor	SEWER	Effic.-ROF	Elect.	Elect.	\$2,761	-\$414	7	\$57	4.0	\$12	\$263	0.10
Pumps/Motors	Old	5 Lift Pump Motor	SEWER	2-SPD-RI	Elect.	Elect.	\$701	-\$225	5	\$68	0.4	\$2	\$82	0.09
Pumps/Motors	Old	5 Lift Pump Motor	SEWER	2-SPD-ROF	Elect.	Elect.	\$409	-\$239	5	\$37	0.4	\$1	\$138	0.34
Pumps/Motors	Old	5 Lift Pump Motor	SEWER	Effic.-RI	Elect.	Elect.	\$422	\$27	1	\$12	0.4	\$2	-\$197	-0.47
Pumps/Motors	Old	5 Lift Pump Motor	SEWER	Effic.-ROF	Elect.	Elect.	\$246	-\$36	1	\$6	0.4	\$1	\$39	0.16
Pumps/Motors	Old	6 Lift Pump Motor	SEWER	2-SPD-RI	Elect.	Elect.	\$947	-\$244	13	\$181	1.7	\$9	\$1,486	1.57
Pumps/Motors	Old	6 Lift Pump Motor	SEWER	2-SPD-ROF	Elect.	Elect.	\$552	-\$285	13	\$99	1.7	\$6	\$725	1.31
Pumps/Motors	Old	6 Lift Pump Motor	SEWER	Effic.-RI	Elect.	Elect.	\$603	\$32	2	\$20	1.0	\$6	-\$132	-0.22
Pumps/Motors	Old	6 Lift Pump Motor	SEWER	Effic.-ROF	Elect.	Elect.	\$352	-\$58	2	\$14	1.0	\$3	\$109	0.31
Pumps/Motors	Old	6 Lift Pump Motor	SEWER	2-SPD-RI	Elect.	Elect.	\$701	-\$225	7	\$89	0.8	\$4	\$528	0.76
Pumps/Motors	Old	7 Lift Pump Motor	SEWER	2-SPD-ROF	Elect.	Elect.	\$409	-\$239	7	\$54	0.8	\$2	\$318	0.77
Pumps/Motors	Old	7 Lift Pump Motor	SEWER	Effic.-RI	Elect.	Elect.	\$422	\$27	1	\$17	0.8	\$3	-\$108	-0.26
Pumps/Motors	Old	7 Lift Pump Motor	SEWER	Effic.-ROF	Elect.	Elect.	\$246	-\$36	1	\$9	0.8	\$2	\$74	0.30
Pumps/Motors	Old	8 Lift Pump Motor	SEWER	2-SPD-RI	Elect.	Elect.	\$701	-\$225	6	\$87	0.8	\$4	\$366	0.62
Pumps/Motors	Old	8 Lift Pump Motor	SEWER	2-SPD-ROF	Elect.	Elect.	\$409	-\$238	6	\$48	0.8	\$2	\$263	0.62
Pumps/Motors	Old	8 Lift Pump Motor	SEWER	Effic.-RI	Elect.	Elect.	\$422	\$27	1	\$15	0.8	\$3	-\$132	-0.31
Pumps/Motors	Old	8 Lift Pump Motor	SEWER	Effic.-ROF	Elect.	Elect.	\$246	-\$36	1	\$8	0.8	\$2	\$84	0.28
Pumps/Motors	Old	9 Lift Pump Motor	SEWER	2-SPD-RI	Elect.	Elect.	\$822	-\$218	0	\$2	0.0	\$0	-\$807	-1.30
Pumps/Motors	Old	9 Lift Pump Motor	SEWER	2-SPD-ROF	Elect.	Elect.	\$383	-\$220	0	\$1	0.0	\$0	-\$208	-0.67
Pumps/Motors	Old	9 Lift Pump Motor	SEWER	Effic.-RI	Elect.	Elect.	\$383	\$18	0	\$1	0.0	\$0	-\$358	-0.93
Pumps/Motors	Old	9 Lift Pump Motor	SEWER	Effic.-ROF	Elect.	Elect.	\$223	-\$38	0	\$0	0.0	\$0	-\$35	-0.16
Pumps/Motors	New	1 HW Pump	SHP	Effic.-RI	Elect.	Elect.	\$22,440	\$1,970	81	\$1,184	56.0	\$309	\$534	0.02
Pumps/Motors	New	10 MAHU	SHP	Effic.-ROF	Elect.	Elect.	\$13,081	-\$1,385	81	\$647	56.0	\$169	\$8,615	0.51
Pumps/Motors	New	10 MAHU	SHP	2-SPD-RI	Elect.	Elect.	\$27,424	-\$7,737	689	\$10,818	-131.1	-\$722	\$104,148	3.80
Pumps/Motors	New	10 MAHU	SHP	2-SPD-ROF	Elect.	Elect.	\$16,948	-\$8,949	689	\$6,803	-131.1	-\$385	\$44,178	2.76
Pumps/Motors	New	10 MAHU	SHP	Effic.-RI	Elect.	Elect.	\$16,940	\$1,014	49	\$780	112.9	\$622	\$4,110	0.25
Pumps/Motors	New	10 MAHU	SHP	Effic.-ROF	Elect.	Elect.	\$9,700	-\$1,481	49	\$428	112.9	\$340	\$6,046	0.82
Pumps/Motors	New	10 MAHU	SHP	2-SPD-RI	Elect.	Elect.	\$12,419	-\$2,708	341	\$5,419	66.9	-\$368	\$55,982	4.51
Pumps/Motors	New	11 MAHU	SHP	2-SPD-ROF	Elect.	Elect.	\$7,239	-\$3,674	341	\$2,961	-66.9	-\$201	\$23,537	3.25
Pumps/Motors	New	11 MAHU	SHP	Effic.-RI	Elect.	Elect.	\$8,228	\$482	26	\$420	57.0	\$314	\$2,688	0.31
Pumps/Motors	New	11 MAHU	SHP	Effic.-ROF	Elect.	Elect.	\$4,796	-\$752	26	\$230	57.0	\$172	\$3,189	0.66

TABLE 3.4. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1982 \$)	Present Value of O&M Savings (1982 \$)	Annual Energy Savings (MMBtu)	Value of Annual Energy Savings (1982 \$)	Annual Demand Savings (KW-mo)	Value of Annual Demand Savings (1982 \$)	Net Present Value of ERO (1982 \$)	Value Index
Pump/Motors	New	3 Air Comp	SHP	Effic.-RI	Elect.	Elect.	\$8,228	\$482	14	\$224	25.3	\$139	-\$2,631	-0.32
Pump/Motors	New	3 Air Comp	SHP	Effic.-ROF	Elect.	Elect.	\$4,786	-\$762	14	\$122	25.3	\$76	\$1,199	0.26
Pump/Motors	New	4 Exh Fans	SHP	2-SPD-RI	Elect.	Elect.	\$37,472	-\$13,688	286	\$4,660	-108.2	-\$696	\$4,496	0.12
Pump/Motors	New	4 Exh Fans	SHP	2-SPD-ROF	Elect.	Elect.	\$21,844	-\$13,604	286	\$2,488	-108.2	-\$328	\$7,720	0.36
Pump/Motors	New	4 Exh Fans	SHP	Effic.-RI	Elect.	Elect.	\$21,120	\$1,864	33	\$582	70.1	\$386	-\$5,911	-0.28
Pump/Motors	New	4 Exh Fans	SHP	Effic.-ROF	Elect.	Elect.	\$12,312	-\$1,313	33	\$307	70.1	\$211	\$3,780	0.31
Pump/Motors	New	6 SMF Fans	SHP	2-SPD-RI	Elect.	Elect.	\$11,981	-\$4,639	148	\$2,190	-68.3	-\$321	\$5,360	0.78
Pump/Motors	New	6 SMF Fans	SHP	2-SPD-ROF	Elect.	Elect.	\$6,894	-\$4,431	148	\$1,180	-68.3	-\$176	\$5,438	0.78
Pump/Motors	New	6 SMF Fans	SHP	Effic.-RI	Elect.	Elect.	\$6,636	\$563	21	\$311	43.0	\$237	\$1,026	0.26
Pump/Motors	New	6 SMF Fans	SHP	Effic.-ROF	Elect.	Elect.	\$3,898	-\$442	21	\$170	43.0	\$129	\$2,488	0.66
Pump/Motors	New	6 Exh Fans	SHP	2-SPD-RI	Elect.	Elect.	\$88,286	-\$23,871	1,069	\$18,348	-428.4	-\$2,348	\$133,087	1.85
Pump/Motors	New	6 Exh Fans	SHP	2-SPD-ROF	Elect.	Elect.	\$39,795	-\$24,406	1,069	\$10,028	-428.4	-\$1,284	\$81,483	1.55
Pump/Motors	New	6 Exh Fans	SHP	Effic.-RI	Elect.	Elect.	\$38,841	\$2,898	104	\$1,787	217.6	\$1,199	\$6,086	0.16
Pump/Motors	New	6 Exh Fans	SHP	Effic.-ROF	Elect.	Elect.	\$22,842	-\$2,927	104	\$978	217.6	\$656	\$13,101	0.68
Pump/Motors	New	7 MP HHCBN	SHP	2-SPD-RI	Elect.	Elect.	\$8,231	-\$2,657	168	\$2,301	-30.4	-\$168	\$19,244	2.34
Pump/Motors	New	7 MP HHCBN	SHP	2-SPD-ROF	Elect.	Elect.	\$4,798	-\$2,794	168	\$1,267	-30.4	-\$92	\$8,069	1.80
Pump/Motors	New	7 MP HHCBN	SHP	Effic.-RI	Elect.	Elect.	\$5,049	\$254	15	\$213	28.5	\$163	\$486	0.10
Pump/Motors	New	7 MP HHCBN	SHP	Effic.-ROF	Elect.	Elect.	\$2,943	-\$503	15	\$117	28.5	\$89	\$1,514	0.81
Pump/Motors	New	8 SMF Fan	SHP	2-SPD-RI	Elect.	Elect.	\$17,997	-\$6,078	612	\$7,495	-67.3	-\$316	\$77,661	4.31
Pump/Motors	New	8 SMF Fan	SHP	2-SPD-ROF	Elect.	Elect.	\$10,481	-\$6,872	612	\$4,078	-67.3	-\$173	\$32,606	3.10
Pump/Motors	New	8 SMF Fan	SHP	Effic.-RI	Elect.	Elect.	\$10,920	\$686	38	\$648	49.4	\$272	\$1,296	0.12
Pump/Motors	New	8 SMF Fan	SHP	Effic.-ROF	Elect.	Elect.	\$6,366	-\$972	38	\$300	49.4	\$149	\$3,432	0.64
Pump/Motors	New	9 MAHU	SHP	2-SPD-RI	Elect.	Elect.	\$20,416	-\$7,139	320	\$5,073	-143.4	-\$790	\$32,728	1.60
Pump/Motors	New	9 MAHU	SHP	2-SPD-ROF	Elect.	Elect.	\$11,801	-\$7,289	320	\$2,772	-143.4	-\$432	\$15,680	1.32
Pump/Motors	New	9 MAHU	SHP	Effic.-RI	Elect.	Elect.	\$11,816	\$897	31	\$484	72.4	\$389	\$1,819	0.16
Pump/Motors	New	9 MAHU	SHP	Effic.-ROF	Elect.	Elect.	\$6,771	-\$876	31	\$270	72.4	\$218	\$3,918	0.68
Pump/Motors	New	1 HW Pump	SMA	Effic.-RI	Elect.	Elect.	\$6,670	\$840	35	\$606	23.8	\$131	\$221	0.02
Pump/Motors	New	1 HW Pump	SMA	Effic.-ROF	Elect.	Elect.	\$6,678	-\$685	35	\$278	23.8	\$72	\$2,415	0.61
Pump/Motors	New	10 MAHU	SMA	2-SPD-RI	Elect.	Elect.	\$11,141	-\$3,143	272	\$4,314	-63.2	-\$293	\$42,314	3.80
Pump/Motors	New	10 MAHU	SMA	2-SPD-ROF	Elect.	Elect.	\$6,494	-\$3,635	272	\$2,357	-63.2	-\$180	\$17,948	2.76
Pump/Motors	New	10 MAHU	SMA	Effic.-RI	Elect.	Elect.	\$6,780	\$412	20	\$317	46.9	\$253	\$1,672	0.26
Pump/Motors	New	10 MAHU	SMA	Effic.-ROF	Elect.	Elect.	\$6,845	-\$1,231	20	\$173	46.9	\$138	\$2,467	0.82
Pump/Motors	New	11 MAHU	SMA	2-SPD-RI	Elect.	Elect.	\$3,291	-\$1,024	165	\$2,463	-30.4	-\$168	\$26,439	4.61
Pump/Motors	New	11 MAHU	SMA	2-SPD-ROF	Elect.	Elect.	\$3,740	-\$219	165	\$1,346	-30.4	-\$92	\$10,699	3.25
Pump/Motors	New	11 MAHU	SMA	Effic.-RI	Elect.	Elect.	\$2,180	-\$342	12	\$191	28.0	\$143	\$1,184	0.32
Pump/Motors	New	11 MAHU	SMA	Effic.-ROF	Elect.	Elect.	\$2,740	-\$219	12	\$104	28.0	\$78	\$1,452	0.67
Pump/Motors	New	3 Air Comp	SMA	Effic.-RI	Elect.	Elect.	\$3,740	\$219	6	\$96	11.8	\$64	-\$1,277	-0.34
Pump/Motors	New	3 Air Comp	SMA	Effic.-ROF	Elect.	Elect.	\$2,180	-\$342	6	\$52	11.8	\$36	\$514	0.24
Pump/Motors	New	4 Exh Fans	SMA	2-SPD-RI	Elect.	Elect.	\$16,808	-\$5,776	112	\$1,919	-46.7	-\$252	\$1,892	0.12
Pump/Motors	New	4 Exh Fans	SMA	2-SPD-ROF	Elect.	Elect.	\$9,218	-\$5,687	112	\$1,049	-46.7	-\$138	\$3,266	0.35
Pump/Motors	New	4 Exh Fans	SMA	Effic.-RI	Elect.	Elect.	\$8,910	\$782	14	\$237	29.6	\$163	-\$2,492	-0.28
Pump/Motors	New	4 Exh Fans	SMA	Effic.-ROF	Elect.	Elect.	\$5,194	-\$654	14	\$130	29.6	\$89	\$1,596	0.31
Pump/Motors	New	5 SMF Fans	SMA	2-SPD-RI	Elect.	Elect.	\$6,135	-\$1,946	64	\$928	-26.0	-\$138	\$4,009	0.78
Pump/Motors	New	5 SMF Fans	SMA	2-SPD-ROF	Elect.	Elect.	\$2,844	-\$237	64	\$508	-26.0	-\$101	\$2,330	0.78
Pump/Motors	New	5 SMF Fans	SMA	Effic.-RI	Elect.	Elect.	\$2,844	\$237	9	\$133	18.4	\$101	\$694	0.24
Pump/Motors	New	5 SMF Fans	SMA	Effic.-ROF	Elect.	Elect.	\$1,958	-\$189	9	\$73	18.4	\$55	\$1,070	0.65
Pump/Motors	New	6 Exh Fans	SMA	2-SPD-RI	Elect.	Elect.	\$28,710	-\$10,029	449	\$7,717	-179.4	-\$988	\$56,976	1.85
Pump/Motors	New	6 Exh Fans	SMA	2-SPD-ROF	Elect.	Elect.	\$18,738	-\$10,264	449	\$4,217	-179.4	-\$540	\$25,868	1.55
Pump/Motors	New	6 Exh Fans	SMA	Effic.-RI	Elect.	Elect.	\$10,335	\$1,229	44	\$761	91.5	\$604	\$6,989	0.16
Pump/Motors	New	6 Exh Fans	SMA	Effic.-ROF	Elect.	Elect.	\$9,522	-\$1,220	44	\$411	91.5	\$276	\$6,620	0.58
Pump/Motors	New	7 MP HHCBN	SMA	2-SPD-RI	Elect.	Elect.	\$2,181	-\$1,182	72	\$1,046	-13.8	-\$76	\$8,749	2.34
Pump/Motors	New	7 MP HHCBN	SMA	2-SPD-ROF	Elect.	Elect.	\$2,181	-\$1,270	72	\$672	-13.8	-\$42	\$3,937	1.81
Pump/Motors	New	7 MP HHCBN	SMA	Effic.-RI	Elect.	Elect.	\$1,295	\$116	7	\$97	13.5	\$74	\$233	0.10
Pump/Motors	New	7 MP HHCBN	SMA	Effic.-ROF	Elect.	Elect.	\$1,338	-\$229	7	\$63	13.5	\$41	\$691	0.52
Pump/Motors	New	8 SMF Fan	SMA	2-SPD-RI	Elect.	Elect.	\$7,713	-\$2,176	220	\$3,199	-24.6	-\$136	\$33,237	4.31

TABLE 3.4. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1992 \$)	Present Value of O&M Savings (1992 \$)	Annual Energy Savings (MMBtu)	Value of Energy Savings (1992 \$)	Annual Demand Savings (KW-mo)	Value of Annual Demand Savings (1992 \$)	Net Present Value of ERO (1992 \$)	Value Index
Pumps/Motors	New	8 SMF Fan	SMA	2-SPD-ROF	Elect.	Elect.	\$4,498	-\$2,517	220	\$1,748	-24.6	-\$74	\$13,929	3.10
Pumps/Motors	New	8 SMF Fan	SMA	Efficient-R	Elect.	Elect.	\$4,680	\$285	16	\$235	21.2	\$117	\$557	0.12
Pumps/Motors	New	8 SMF Fan	SMA	Efficient-R	Elect.	Elect.	\$2,728	-\$417	16	\$128	21.2	\$64	\$1,472	0.54
Pumps/Motors	New	9 MAHU	SMA	2-SPD-ROF	Elect.	Elect.	\$8,294	-\$2,800	130	\$2,061	-68.3	-\$321	\$13,293	1.60
Pumps/Motors	New	9 MAHU	SMA	Efficient-R	Elect.	Elect.	\$4,836	-\$2,885	130	\$1,128	-58.3	-\$178	\$6,373	0.16
Pumps/Motors	New	9 MAHU	SMA	Efficient-R	Elect.	Elect.	\$4,719	\$352	13	\$201	25.7	\$164	\$762	0.16
Pumps/Motors	New	9 MAHU	SMA	Efficient-R	Elect.	Elect.	\$2,761	-\$356	13	\$110	25.7	\$89	\$1,600	0.68
Peak-Shave	Old/New	Peak-Shave	NA	DGEN-1	Elect.	Diesel	\$48,700	-\$810	-58	\$38	7,200.0	\$39,672	\$508,190	10.44
Peak-Shave	Old/New	Peak-Shave	NA	DGEN-2	Elect.	Diesel	\$70,483	-\$50,547	-3,159	\$1,948	12,600.0	\$69,428	\$819,884	11.83
Peak-Shave	Old/New	Peak-Shave	NA	DGEN-3	Elect.	Diesel	\$116,964	-\$106,260	-6,527	\$4,021	16,800.0	\$92,668	\$1,029,334	11.21
Peak-Shave	Old/New	Peak-Shave	NA	DGEN-4	Elect.	Diesel	\$116,964	-\$106,260	-6,527	\$4,021	16,800.0	\$92,668	\$1,029,334	11.21
Peak-Shave	Old/New	Peak-Shave	NA	DGEN-5	Elect.	Diesel	\$138,597	-\$280,602	-12,070	\$7,436	21,000.0	\$116,710	\$1,174,412	10.13
Peak-Shave	Old/New	Peak-Shave	NA	DGEN-6	Elect.	Diesel	\$153,588	-\$280,602	-12,070	\$7,436	21,000.0	\$116,710	\$1,174,412	10.13
Peak-Shave	Old/New	Peak-Shave	NA	DGEN-7	Elect.	Diesel	\$173,697	-\$447,451	-26,152	\$15,111	29,400.0	\$161,984	\$1,343,634	8.76
Peak-Shave	Old/New	Peak-Shave	NA	DGEN-8	Elect.	Diesel	\$173,697	-\$447,451	-26,152	\$15,111	29,400.0	\$161,984	\$1,343,634	8.76
Peak-Shave	Old/New	Peak-Shave	NA	DGEN-9	Elect.	Diesel	\$194,000	-\$517,532	-29,802	\$18,300	31,200.0	\$171,912	\$1,362,873	7.81
Peak-Shave	Old/New	Peak-Shave	NA	DGEN-10	Elect.	Diesel	\$216,506	-\$611,948	-34,046	\$21,344	32,400.0	\$178,524	\$1,283,870	5.96
Peak-Shave	Old/New	Peak-Shave	NA	DGEN-11	Elect.	Diesel	\$237,806	-\$656,316	-36,508	\$22,491	33,300.0	\$183,483	\$1,266,410	5.32
Peak-Shave	Old/New	Peak-Shave	NA	DGEN-12	Elect.	Diesel	\$280,652	-\$704,250	-38,520	\$23,730	34,100.0	\$189,111	\$1,236,466	4.74
Peak-Shave	Old/New	Peak-Shave	NA	DGEN-13	Elect.	Diesel	\$284,081	-\$765,576	-40,690	\$25,061	34,980.0	\$192,740	\$1,201,800	4.23
Pumps/Motors	New	AHU Fan	ADM	CO2 Sensor	Elect.	Elect.	\$28,215	-\$87,282	1,221	\$7,643	0.0	\$0	\$3,888	0.14
Pumps/Motors	New	AHU Fan	ADM	CO2 Sensor	Elect.	Elect.	\$28,215	-\$87,282	1,221	\$7,643	0.0	\$0	\$3,888	0.14
Pumps/Motors	New	Summer Vent.	ADM	CO2 Sensor	Elect.	Elect.	\$28,215	-\$87,282	1,221	\$7,643	0.0	\$0	\$3,888	0.14
Pumps/Motors	New	Summer Vent.	ADM	CO2 Sensor	Elect.	Elect.	\$28,215	-\$87,282	1,221	\$7,643	0.0	\$0	\$3,888	0.14
Refer.	Off	Refer.	ADM	CO2 Sensor	Elect.	Elect.	\$28,215	-\$87,282	1,221	\$7,643	0.0	\$0	\$3,888	0.14
Refer.	On	Refer.	ADM	CO2 Sensor	Elect.	Elect.	\$28,215	-\$87,282	1,221	\$7,643	0.0	\$0	\$3,888	0.14
Refer.	Old/New	Refer.	ADM	CO2 Sensor	Elect.	Elect.	\$28,215	-\$87,282	1,221	\$7,643	0.0	\$0	\$3,888	0.14
Streetlights	New	HPS Strips	BAR	Efficient-R	Elect.	Elect.	\$3,114	\$49,138	1,070	\$15,759	1,763	\$8,069	-\$656,570	-0.48
Streetlights	New	HPS Strips	NA	Delamp 4-Lane	Elect.	Elect.	\$2,996	\$40,848	1,066	\$14,469	1,066	\$4,976	\$310,674	119.72
Streetlights	New	HPS Strips	NA	Delamp 4-Lane	Elect.	Elect.	\$2,996	\$40,848	1,066	\$14,469	1,066	\$4,976	\$310,674	119.72
Streetlights	New	HPS Strips	NA	Reduce OpHrs	Elect.	Elect.	\$23,680	\$60,488	2,321	\$31,831	1,947.0	\$10,728	\$883,482	119.72
Streetlights	New	HPS Strips	NA	Reduce OpHrs + Dimp 4-Lane	Elect.	Elect.	\$26,275	\$89,851	2,126	\$28,223	886.0	\$4,876	\$529,371	20.16
Streetlights	New	HPS Strips	NA	Reduce OpHrs + Dimp 4-Lane	Elect.	Elect.	\$26,275	\$89,851	2,126	\$28,223	886.0	\$4,876	\$529,371	20.16
Streetlights	Old	Merc Strips	NA	Install HPS 250	Elect.	Elect.	\$28,389	\$124,753	2,868	\$39,113	1,947.0	\$10,728	\$883,482	119.72
Streetlights	Old	Merc Strips	NA	Install HPS 250	Elect.	Elect.	\$28,389	\$124,753	2,868	\$39,113	1,947.0	\$10,728	\$883,482	119.72
Weather.	On	Heating	RAV	Window Quits	Elect.	Elect.	\$54,386	-\$4,124	776	\$7,892	482.0	\$2,666	\$96,011	1.41
Weather.	On	Heating	RAV	Window Quits	Elect.	Elect.	\$54,386	-\$4,124	776	\$7,892	482.0	\$2,666	\$96,011	1.41
Weather.	On	Heating	RAV	Ceiling Insulation-40	Elect.	Elect.	\$28,000	\$0	251	\$3,808	94.0	\$518	\$32,293	1.13
Weather.	On	Heating	RAV	Ceiling Insulation-60	Elect.	Elect.	\$42,128	\$0	301	\$4,569	112.0	\$617	\$30,881	0.73
Weather.	On	Heating	RAV	Ceiling Insulation-60	Elect.	Elect.	\$42,128	\$0	301	\$4,569	112.0	\$617	\$30,881	0.73
Trans. & Dist.	Old/New	Trans. & Dist.	NA	CVR1-1	Elect.	Elect.	\$56,668	\$0	336	\$6,079	125.0	\$689	\$26,539	0.48
Trans. & Dist.	Old/New	Trans. & Dist.	NA	CVR2-1	Elect.	Elect.	\$400	\$0	1,986	\$25,011	870.4	\$4,796	\$419,193	1,047.88
Trans. & Dist.	Old/New	Trans. & Dist.	NA	CVR2-1	Elect.	Elect.	\$400	\$0	1,986	\$25,011	870.4	\$4,796	\$419,193	1,047.88
Trans. & Dist.	Old/New	Trans. & Dist.	NA	Pwr/Cor b (h)	Elect.	Elect.	\$7,722	-\$236	53	\$781	436.2	\$2,398	\$209,300	523.26
Trans. & Dist.	Old/New	Trans. & Dist.	NA	Pwr/Cor b (h)	Elect.	Elect.	\$7,722	-\$236	53	\$781	436.2	\$2,398	\$209,300	523.26
Trans. & Dist.	Old/New	Trans. & Dist.	NA	5 High Eff. Transfmr (h)	Elect.	Elect.	\$11,402	-\$3,810	68	\$997	33.8	\$186	\$261,209	22.03
Trans. & Dist.	Old/New	Trans. & Dist.	NA	5 High Eff. Transfmr (h)	Elect.	Elect.	\$11,402	-\$3,810	68	\$997	33.8	\$186	\$261,209	22.03
Trans. & Dist.	Old/New	Trans. & Dist.	NA	8 High Eff. Transfmr (h)	Elect.	Elect.	\$152,810	\$0	80	\$1,316	42.1	\$232	-\$130,834	-0.86
Trans. & Dist.	Old/New	Trans. & Dist.	NA	8 High Eff. Transfmr (h)	Elect.	Elect.	\$152,810	\$0	80	\$1,316	42.1	\$232	-\$130,834	-0.86
Trans. & Dist.	Old/New	Trans. & Dist.	NA	16 High Eff. Transfmr (h)	Elect.	Elect.	\$356,900	\$0	164	\$2,261	74.0	\$407	-\$236,955	-0.86
Trans. & Dist.	Old/New	Trans. & Dist.	NA	16 High Eff. Transfmr (h)	Elect.	Elect.	\$356,900	\$0	164	\$2,261	74.0	\$407	-\$236,955	-0.86
Trans. & Dist.	Old/New	Trans. & Dist.	NA	20 High Eff. Transfmr (h)	Elect.	Elect.	\$123,883	\$0	6	\$84	1.5	\$8	-\$11,576	-0.90
Trans. & Dist.	Old/New	Trans. & Dist.	NA	20 High Eff. Transfmr (h)	Elect.	Elect.	\$123,883	\$0	6	\$84	1.5	\$8	-\$11,576	-0.90
Trans. & Dist.	Old/New	Trans. & Dist.	NA	21 High Eff. Transfmr (h)	Elect.	Elect.	\$302,084	\$0	16	\$220	6.7	\$37	-\$19,851	-0.86
Trans. & Dist.	Old/New	Trans. & Dist.	NA	21 High Eff. Transfmr (h)	Elect.	Elect.	\$302,084	\$0	16	\$220	6.7	\$37	-\$19,851	-0.86
Trans. & Dist.	Old/New	Trans. & Dist.	NA	23 High Eff. Transfmr (h)	Elect.	Elect.	\$69,876	\$0	57	\$827	23.9	\$132	-\$66,337	-0.81
Trans. & Dist.	Old/New	Trans. & Dist.	NA	23 High Eff. Transfmr (h)	Elect.	Elect.	\$69,876	\$0	57	\$827	23.9	\$132	-\$66,337	-0.81
Trans. & Dist.	Old/New	Trans. & Dist.	NA	24 High Eff. Transfmr (h)	Elect.	Elect.	\$15,160	\$0	12	\$181	6.2	\$29	-\$12,191	-0.80
Trans. & Dist.	Old/New	Trans. & Dist.	NA	24 High Eff. Transfmr (h)	Elect.	Elect.	\$15,160	\$0	12	\$181	6.2	\$29	-\$12,191	-0.80
Trans. & Dist.	Old/New	Trans. & Dist.	NA	26 High Eff. Transfmr (h)	Elect.	Elect.	\$124,720	\$0	98	\$1,420	41.9	\$231	-\$101,484	-0.81
Trans. & Dist.	Old/New	Trans. & Dist.	NA	26 High Eff. Transfmr (h)	Elect.	Elect.	\$124,720	\$0	98	\$1,420	41.9	\$231	-\$101,484	-0.81
Trans. & Dist.	Old/New	Trans. & Dist.	NA	27 High Eff. Transfmr (h)	Elect.	Elect.	\$939,500	\$0	978	\$14,265	406.8	\$2,236	-\$706,862	-0.76
Trans. & Dist.	Old/New	Trans. & Dist.	NA	27 High Eff. Transfmr (h)	Elect.	Elect.	\$939,500	\$0	978	\$14,265	406.8	\$2,236	-\$706,862	-0.76
Trans. & Dist.	Old/New	Trans. & Dist.	NA	27 High Eff. Transfmr (h)	Elect.	Elect.	\$46,940	\$0	57	\$832	27.3	\$151	-\$31,507	-0.89

TABLE 3.4. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1992 \$)	Present Value of O&M Savings (1992 \$)	Annual Energy Savings (MBtu)	Value of Annual Energy Savings (1992 \$)	Annual Demand Savings (KW-mo)	Value of Annual Demand Savings (1992 \$)	Net Present Value of ERO (1992 \$)	Value Index
Trans. & Dist.	New	Trans.	NA	28 High Eff. Transfmr (h)	Elect.	Elect.	\$65,660	\$0	80	\$876	28.1	\$144	-\$40,815	-0.73
Trans. & Dist.	New	Trans.	NA	29 High Eff. Transfmr (h)	Elect.	Elect.	\$32,785	\$0	42	\$810	18.1	\$100	-\$22,529	-0.88
Trans. & Dist.	New	Trans.	NA	30 High Eff. Transfmr (h)	Elect.	Elect.	\$40,815	\$0	55	\$813	38.4	\$212	-\$24,874	-0.81
Trans. & Dist.	Old	Trans.	NA	1 High Eff. Transfmr (h)	Elect.	Elect.	\$73,867	\$0	41	\$806	26.0	\$138	-\$83,366	-0.88
Trans. & Dist.	Old	Trans.	NA	2 High Eff. Transfmr (h)	Elect.	Elect.	\$2,268	\$0	2	\$24	0.8	\$4	-\$2,859	-0.88
Trans. & Dist.	Old	Trans.	NA	3 High Eff. Transfmr (h)	Elect.	Elect.	\$93,889	\$0	47	\$888	26.4	\$140	-\$92,110	-0.87
Trans. & Dist.	Old	Trans.	NA	4 High Eff. Transfmr (h)	Elect.	Elect.	\$64,701	\$0	27	\$392	16.5	\$91	-\$67,850	-0.89
Trans. & Dist.	Old	Trans.	NA	5 High Eff. Transfmr (h)	Elect.	Elect.	\$263,820	\$0	128	\$1,848	80.4	\$443	-\$221,145	-0.87
Trans. & Dist.	Old	Trans.	NA	6 High Eff. Transfmr (h)	Elect.	Elect.	\$649,290	\$0	314	\$4,801	187.4	\$1,033	-\$486,778	-0.86
Trans. & Dist.	Old	Trans.	NA	7 High Eff. Transfmr (h)	Elect.	Elect.	\$313,740	\$0	171	\$2,500	111.7	\$816	-\$289,063	-0.86
Trans. & Dist.	Old	Trans.	NA	8 High Eff. Transfmr (h)	Elect.	Elect.	\$12,522	\$0	8	\$122	4.5	\$25	-\$10,428	-0.83
Trans. & Dist.	Old	Trans.	NA	9 High Eff. Transfmr (h)	Elect.	Elect.	\$145,000	\$0	92	\$1,348	48.1	\$265	-\$121,895	-0.84
Trans. & Dist.	Old	Trans.	NA	10 High Eff. Transfmr (h)	Elect.	Elect.	\$30,432	\$0	23	\$345	14.3	\$79	-\$24,305	-0.80
Trans. & Dist.	Old	Trans.	NA	11 High Eff. Transfmr (h)	Elect.	Elect.	\$12,472	\$0	14	\$202	8.3	\$48	-\$8,856	-0.71
Trans. & Dist.	Old	Trans.	NA	12 High Eff. Transfmr (h)	Elect.	Elect.	\$2,036	\$0	1	\$12	0.4	\$2	-\$1,834	-0.90
Trans. & Dist.	Old	Trans.	NA	13 High Eff. Transfmr (h)	Elect.	Elect.	\$10,203	\$0	6	\$78	2.7	\$15	-\$8,897	-0.87
Trans. & Dist.	Old	Trans.	NA	14 High Eff. Transfmr (h)	Elect.	Elect.	\$22,067	\$0	10	\$141	6.2	\$29	-\$19,659	-0.89
Trans. & Dist.	Old	Trans.	NA	15 High Eff. Transfmr (h)	Elect.	Elect.	\$8,575	\$0	4	\$66	2.4	\$13	-\$7,457	-0.87
Trans. & Dist.	Old	Trans.	NA	16 High Eff. Transfmr (h)	Elect.	Elect.	\$4,762	\$0	3	\$37	1.3	\$7	-\$4,118	-0.87
Trans. & Dist.	Old	Trans.	NA	17 High Eff. Transfmr (h)	Elect.	Elect.	\$10,325	\$0	6	\$92	3.4	\$19	-\$8,745	-0.85
Trans. & Dist.	Old	Trans.	NA	18 High Eff. Transfmr (h)	Elect.	Elect.	\$11,165	\$0	7	\$98	3.5	\$19	-\$9,504	-0.85
Trans. & Dist.	Old	Trans.	NA	19 High Eff. Transfmr (h)	Elect.	Elect.	\$18,075	\$0	11	\$158	6.9	\$33	-\$15,988	-0.88
Trans. & Dist.	Old	Trans.	NA	20 High Eff. Transfmr (h)	Elect.	Elect.	\$23,478	\$0	16	\$231	8.4	\$46	-\$19,536	-0.83
Trans. & Dist.	Old	Trans.	NA	22 High Eff. Transfmr (h)	Elect.	Elect.	\$25,360	\$0	17	\$248	9.2	\$51	-\$21,124	-0.83
Trans. & Dist.	Old	Trans.	NA	23 High Eff. Transfmr (h)	Elect.	Elect.	\$83,850	\$0	79	\$1,164	44.6	\$248	-\$83,855	-0.76
Trans. & Dist.	Old	Trans.	NA	25 High Eff. Transfmr (h)	Elect.	Elect.	\$82,380	\$0	90	\$877	31.1	\$171	-\$47,467	-0.76
Trans. & Dist.	Old	Trans.	NA	27 High Eff. Transfmr (h)	Elect.	Elect.	\$2,870	\$0	29	\$429	17.2	\$85	-\$15,080	-0.68
AC	Old/New	AC	NA	Com. WAC-1.5/9.0	Elect.	Elect.	\$25,400	\$0	68	\$1,128	124.4	\$685	\$1,208	0.04
AC	Old/New	AC	NA	Com. WAC-1.5/9.5	Elect.	Elect.	\$34,300	\$0	76	\$1,280	141.4	\$779	-\$6,252	-0.18
AC	Old/New	AC	NA	Com. WAC-1.2/10	Elect.	Elect.	\$31,850	\$0	86	\$1,470	226.2	\$1,241	\$8,393	0.26

Notes:

(a) These fixtures are not considered for sensor retrofits.

(b) These fixtures are considered for sensor retrofits.

(c) Optimal choice was no retrofit. Therefore, no value index can be calculated.

(d) On-post natural gas rate.

(e) Off-post natural gas rate.

(f) This option has no installed cost. Therefore, no value index can be calculated.

(g) For an explanation of the letters corresponding to the lighting EROs, see page B2.69.

(h) This option has additional demand savings corresponding to a reduction in reactive demand. These savings are included in the Net Present Value.

TABLE 3.5. LCC Results - Winning EROs

Energy Resource Opportunity Category	Area	End Use	HARD CODE	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1992 \$)	Present Value of O&M Savings (1992 \$)	Annual Energy Savings (MBtu)	Value Of Annual Energy Savings (1992 \$)	Annual Demand Savings (KW-mo)	Value Of Annual Demand Savings (1992 \$)	Net Present Value of ERO (1992 \$)	Value Index
Trans. & Dist.	New	Heating	LOSS	Lower Temp.	Jones (HTHW)	Jones (HTHW)	\$0	\$0	39,000	\$167,505	NA	NA	\$2,824,128	(f)
Trans. & Dist.	Old/New	Trans. & Dist.	NA	CVR1-1	Elect.	Elect.	\$400	\$0	1,896	\$25,011	870.4	\$4,796	\$419,193	1,047.98
Weather.	Old	Heating	NA	CVR2-1	Elect.	Elect.	\$400	\$0	843	\$12,499	435.2	\$2,398	\$209,300	533.25
Trans. & Dist.	New	Heating	BAM	Weatherstrip	Fuel Oil	Fuel Oil	\$178	\$0	153	\$762	NA	NA	\$12,077	71.22
Trans. & Dist.	Old	Heating	LOSS	Line Decommission	Jones (HTHW)	Jones (HTHW)	\$6,130	\$0	3,750	\$16,106	NA	NA	\$265,421	43.30
Weather.	Old	Heating	HAN	Weatherstrip	Fuel Oil	Fuel Oil	\$178	\$0	81	\$404	NA	NA	\$6,646	37.34
Pumps/Motors	New	4 Lift Pump Motor	SEWER	Downsize-R	Elect.	Elect.	\$867	\$860	117	\$1,729	65.1	\$359	\$29,385	33.89
Trans. & Dist.	Old/New	Trans. & Dist.	NA	PwrFCor a (H)	Elect.	Elect.	\$7,722	-\$235	53	\$781	26.5	\$146	\$254,657	32.98
Weather.	Old	Heating	HSP	Weatherstrip	Fuel Oil	Fuel Oil	\$178	\$0	66	\$328	NA	NA	\$5,364	30.13
Streetlights	New	HPS Strips	NA	Ride OpHrs+Dimp 4&2-Lene	Elect.	Elect.	\$25,389	\$124,753	2,888	\$39,113	1,947.0	\$10,728	\$796,973	27.12
Lighting	Old/New	HPS 400 (Ext) (e)	B	Retro All	Elect.	Elect.	\$17,475	\$38,668	1,509	\$20,050	1,040.1	\$5,731	\$384,118	21.98
Weather.	Old	Heating	SHM	Weatherstrip	Fuel Oil	Fuel Oil	\$178	\$0	40	\$198	NA	NA	\$3,161	17.76
Pumps/Motors	New	7 HTHW Pump	CLD	Weatherstrip	Fuel Oil	Fuel Oil	\$178	\$0	39	\$191	NA	NA	\$3,053	17.15
Weather.	Old	Heating	DGR	2-SPD-R	Elect.	Elect.	\$2,571	-\$725	167	\$2,437	-8.2	-\$45	\$30,379	11.82
Pumps/Motors	New	3 AHU Fan	GRO	Weatherstrip	Fuel Oil	Fuel Oil	\$6,586	\$0	1,003	\$4,984	NA	NA	\$77,518	11.77
Pumps/Motors	New	3 AHU Fan	DGR	2-SPD-R	Elect.	Elect.	\$1,578	-\$300	101	\$1,503	-11.8	-\$65	\$19,679	11.73
Controls	Old	Heating	OTH	FM System	Fuel Oil	Elect.	\$857	-\$242	56	\$812	-4.1	-\$23	\$10,020	11.69
Controls	Old	Heating	CLB	FM System	Fuel Oil	Fuel Oil	\$924	\$0	140	\$694	NA	NA	\$10,780	11.67
Controls	Old	Heating	SHF	FM System	Fuel Oil	Fuel Oil	\$816	\$0	88	\$435	NA	NA	\$6,729	10.92
Trans. & Dist.	New	Heating	LOSS	Pipe Insulation	Jones (HTHW)	Jones (HTHW)	\$64,000	\$0	10,000	\$42,950	NA	NA	\$60,274	10.88
Lighting	Old/New	6 FL 2X4 3-34 STD (b)	D	Sensor	Elect.	Elect.	\$4,556	\$11,918	131	\$2,243	102	\$563	\$46,863	10.29
Weather.	Old	Heating	CLB	Weatherstrip	Fuel Oil	Fuel Oil	\$616	\$0	82	\$407	NA	NA	\$6,257	10.16
Pumps/Motors	New	5 AHU Fan	DGR	2-SPD-R	Elect.	Elect.	\$748	-\$232	38	\$558	-3.1	-\$17	\$6,631	8.87
Controls	Old	Hot Water	BAM	New DWH	Fuel Oil	Net. Gas (d)	\$2,077	\$807	42	\$2,075	NA	NA	\$17,928	8.63
Controls	Old	Heating	COM	FM System	Fuel Oil	Fuel Oil	\$616	\$0	70	\$347	NA	NA	\$5,239	8.51
Controls	Old	Heating	BAR	FM System	Fuel Oil	Fuel Oil	\$1,540	\$0	174	\$866	NA	NA	\$13,069	8.49
Furn. & Bfrs.	New	Heating	ASS	Add Pack	Jones (HTHW)	Net. Gas (d)	\$5,042	-\$2,451	773	\$3,155	NA	NA	\$40,010	7.94
Pumps/Motors	Old/New	5 AHU Fan	REC	2-SPD-R	Elect.	Elect.	\$8,856	-\$1,934	307	\$4,469	-32.7	-\$180	\$51,578	7.52
Lighting	Old/New	6b FL 2X4 3-34 STD (b)	A,B	Sensor	Elect.	Elect.	\$14,920	\$28,684	314	\$5,399	246	\$1,354	\$109,131	7.46
Peak-Shave	Old/New	Peak-Shave	NA	DGEN-8	Elect.	Diesel	\$194,000	-\$517,532	-29,802	\$18,360	31,200.0	\$171,912	\$1,362,873	7.03
Controls	Old	Heating	ASS	FM System	Fuel Oil	Fuel Oil	\$4,312	\$0	411	\$2,041	NA	NA	\$30,133	6.99
Controls	New	Heating	ADM	Night Sat	Jones (HTHW)	Jones (HTHW)	\$35,598	\$0	3,907	\$16,781	NA	NA	\$247,322	6.95
Lighting	Old/New	HPS 100 Wall (Ext) (e)	B	Retro All	Elect.	Elect.	\$20,775	\$42,142	502	\$6,684	345.7	\$1,905	\$141,991	6.83
Pumps/Motors	New	Hot Water	SHF	New DWH	Fuel Oil	Net. Gas (d)	\$10,385	\$4,036	656	\$5,867	NA	NA	\$70,575	6.80
Weather.	Old	4 AHU Fan	DGR	2-SPD-R	Elect.	Elect.	\$638	-\$223	27	\$388	-4.5	-\$25	\$4,254	6.67
Controls	Old	Heating	MES	Weatherstrip	Fuel Oil	Fuel Oil	\$308	\$0	16	\$78	NA	NA	\$1,135	6.37
Lighting	Old/New	Inc 60 Cell (e)	C	Retro All	Elect.	Elect.	\$37,920	\$83,608	697	\$10,862	437.3	\$2,410	\$232,514	6.13
Lighting	Old/New	Inc 2X60 Cell (e)	D	Retro All	Elect.	Elect.	\$5,641	\$11,928	108	\$1,632	67.8	\$374	\$34,526	6.12
Lighting	Old/New	Inc 75 Cen (Ext) (e)	B	Retro All	Elect.	Elect.	\$18,757	\$45,201	348	\$4,656	275.8	\$1,541	\$113,689	6.06
Controls	Old	Heating	DGR	FM System	Fuel Oil	Fuel Oil	\$616	\$0	50	\$251	NA	NA	\$3,614	5.87
Controls	Old	Heating	ADM	FM System	Fuel Oil	Fuel Oil	\$12,012	\$0	953	\$4,738	NA	NA	\$67,937	5.66
Pumps/Motors	New	4 AHU Fan	REC	2-SPD-R	Elect.	Elect.	\$5,986	-\$1,860	210	\$3,068	-24.8	-\$137	\$33,417	5.58
Furn. & Bfrs.	Old/New	FL 2X4 4-40 Std (e)	C	Retro All	Elect.	Elect.	\$91,172	\$64,136	1,983	\$30,925	1,245.2	\$6,861	\$504,882	5.54
Lighting	Off	Heating	HSP	Boiler P-Old	Fuel Oil	Net. Gas (d)	\$7,580	\$807	455	\$3,447	NA	NA	\$41,364	5.46
Lighting	Old/New	FL 2X4 6-40 Std (e)	E	Retro All	Elect.	Elect.	\$55,108	\$20,807	176	\$18,131	998.9	\$5,504	\$327,372	5.25
Lighting	Old/New	FL 2X4 6-40 Std (b)	B	Retro&Sensor	Elect.	Elect.	\$36,760	\$30,045	648	\$9,879	567.4	\$3,126	\$176,359	5.25
Lighting	Old/New	Extr 2X20 (e)	B	Retro All	Elect.	Elect.	\$85,040	\$397,925	665	\$9,711	267.1	\$1,472	\$466,305	5.24
Lighting	Old/New	Extr 2X20 (e)	A	Retro All	Elect.	Elect.	\$225,120	\$1,006,078	1,882	\$24,552	675.4	\$3,721	\$1,178,960	5.24
Pumps/Motors	Old/New	Extr 2X20 (e)	D	Retro All	Elect.	Elect.	\$18,060	\$80,712	135	\$1,970	54.2	\$299	\$94,580	5.24
Pumps/Motors	Old	12 HTHW Pump	CLNIC	2-SPD-R	Elect.	Elect.	\$1,497	-\$465	48	\$697	-4.2	\$23	\$7,527	5.03
Pumps/Motors	Old	6 AHU Fan	CLNIC	2-SPD-R	Elect.	Elect.	\$1,714	-\$484	56	\$812	-8.2	\$45	\$8,603	5.02
Weather	Old	Heating	LAU	Weatherstrip	Fuel Oil	Fuel Oil	\$356	\$0	26	\$127	NA	NA	\$1,784	5.01

TABLE 3.5. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1992 \$)	Present Value of O&M Savings (1992 \$)	Annual Energy Savings (MMBtu)	Value Of Energy Savings (1992 \$)	Annual Demand Savings (KW-mo)	Value Of Demand Savings (1992 \$)	Net Present Value of ERO (1992 \$)	Value Index
Pumps/Motors	New	2 AHU Fan	GRO	2-SPD-RI	Elect.	Elect.	\$748	-\$232	24	\$349	-3.1	-\$17	\$3,687	4.93
Weather.	Old	Heating	REC	Weatherstrip	Fuel Oil	Fuel Oil	\$1,802	\$0	111	\$551	NA	NA	\$7,703	4.81
Pumps/Motors	New	1 Chilled Pump	DGR	2-SPD-RI	Elect.	Elect.	\$2,571	-\$725	77	\$1,127	-4.1	-\$23	\$12,255	4.77
Lighting	Old/New	Exit 2X15 (a)	C	Retro All	Elect.	Elect.	\$7,140	\$31,909	38	\$558	15.3	\$84	\$33,786	4.73
Pumps/Motors	New	6 HTHW Pump	REC	2-SPD-RI	Elect.	Elect.	\$121,380	\$542,456	648	\$9,456	260.1	\$1,433	\$574,358	4.71
Lighting	Old/New	Exit 2X15 (a)	B	Sensor	Elect.	Elect.	\$10,208	-\$3,569	320	\$4,858	-47.8	-\$263	\$48,079	4.71
Pumps/Motors	New	6 FL 2X4 3-34 STD (b)	A,B	2-SPD-RI	Elect.	Elect.	\$31,824	\$41,824	456	\$7,836	357	\$1,965	\$143,758	4.64
Pumps/Motors	New	5 AHU-1,2,3	BAR	2-SPD-RI	Elect.	Elect.	\$40,194	-\$14,065	1,258	\$18,339	-282.4	-\$1,556	\$182,004	4.53
Pumps/Motors	New	6 AHU-4	BAR	2-SPD-RI	Elect.	Elect.	\$13,398	-\$4,885	155	\$6,111	-94.2	-\$519	\$60,638	4.51
Pumps/Motors	New	11 MAHU	SMA	2-SPD-RI	Elect.	Elect.	\$5,445	-\$1,231	155	\$2,463	-30.4	-\$168	\$25,439	4.51
Pumps/Motors	New	11 MAHU	SHR	2-SPD-RI	Elect.	Elect.	\$12,419	-\$2,709	341	\$6,419	-66.9	-\$369	\$55,962	4.51
Controls	Old	Heating	WAR	FM System	Fuel Oil	Fuel Oil	\$3,080	\$0	196	\$974	NA	NA	\$13,356	4.34
Pumps/Motors	New	8 SMF Fan	SHR	2-SPD-RI	Elect.	Elect.	\$17,997	-\$5,078	512	\$7,465	-57.3	-\$316	\$77,561	4.31
Pumps/Motors	New	8 SMF Fan	SMA	2-SPD-RI	Elect.	Elect.	\$7,713	-\$2,178	220	\$3,199	-24.6	-\$136	\$33,237	4.31
Weather.	Old	Heating	DGR	Weatherstrip	Fuel Oil	Fuel Oil	\$1,802	\$0	100	\$459	NA	NA	\$6,820	4.26
Lighting	Old/New	5a FL 2X4 4-34 STD (b)	B	Retro & Sensor	Elect.	Elect.	\$44,336	\$49,617	634	\$10,657	427	\$2,355	\$186,453	4.25
Pumps/Motors	New	3 Return Fan	REC	2-SPD-RI	Elect.	Elect.	\$5,104	-\$1,785	133	\$1,941	-12.0	-\$66	\$19,499	3.82
Pumps/Motors	New	10 MAHU	SMA	2-SPD-RI	Elect.	Elect.	\$11,141	-\$3,143	272	\$4,314	-53.2	-\$293	\$42,314	3.80
Pumps/Motors	New	10 MAHU	SHR	2-SPD-RI	Elect.	Elect.	\$27,424	-\$7,737	669	\$10,618	-131.1	-\$722	\$104,146	3.80
Pumps/Motors	New	8 Sup Wtr Pmp	BAR	2-SPD-RI	Elect.	Elect.	\$26,796	-\$9,370	699	\$10,188	-83.7	-\$461	\$100,763	3.76
Lighting	Old/New	Inc 75 Can (a)	B	Retro All	Elect.	Elect.	\$21,462	\$32,970	237	\$3,660	201.7	\$1,111	\$78,676	3.67
Weather.	Old	Heating	COM	Weatherstrip	Fuel Oil	Fuel Oil	\$1,068	\$0	59	\$295	NA	NA	\$3,914	3.66
Hot Water	Old	Hot Water	HSP	New DWH	Fuel Oil	Nat. Gas (d)	\$2,077	\$807	75	\$674	NA	NA	\$7,568	3.64
Pumps/Motors	New	9 AHU Fan	ASS	2-SPD-RI	Elect.	Elect.	\$4,516	-\$985	116	\$1,899	-24.3	-\$134	\$16,385	3.63
Furn. & Bks.	Old	Heating	BAM	Boiler P New	Fuel Oil	Nat. Gas (d)	\$22,740	\$2,422	920	\$7,391	NA	NA	\$80,493	3.54
Lighting	Old/New	5b FL 2X4 4-34 STD (b)	B	Retro & Sensor	Elect.	Elect.	\$44,336	\$44,162	529	\$8,726	427	\$2,355	\$155,815	3.51
Weather.	Old	Heating	BAR	Weatherstrip	Fuel Oil	Fuel Oil	\$35,244	\$0	1,860	\$9,246	NA	NA	\$120,771	3.43
Lighting	Old/New	FL 2X4 4-34 Std (b)	BAR	Retro Sensor	Elect.	Elect.	\$11,809	\$6,485	134	\$2,050	125.4	\$691	\$33,456	3.42 (c)
Lighting	Old/New	FL 2X4 4-34 Std (a)	B	Retro Sensor	Elect.	Elect.	\$18,271	\$376,205	8,344	\$128,638	7,087.4	\$39,052	\$2,118,498	3.42 (c)
Pumps/Motors	New	4 AHU-5,6	BAR	2-SPD-RI	Elect.	Elect.	\$26,796	-\$9,370	587	\$10,083	-188.3	-\$1,038	\$91,172	3.40
Lighting	Off	Inc 3X40 (a)	E	Retro All	Elect.	Elect.	\$38,481	\$43,866	353	\$8,785	0.0	\$0	\$129,048	3.35
Pumps/Motors	Old	11 EXH Fan	CLNIC	2-SPD-RI	Elect.	Elect.	\$1,276	-\$446	27	\$457	-9.0	-\$50	\$4,017	3.15
Furn. & Bks.	Old	Heating	SHR	Boiler P New	Fuel Oil	Nat. Gas (d)	\$106,120	\$11,301	3,873	\$31,133	NA	NA	\$329,836	3.11
Lighting	Old/New	INC 2X60 CEIL (b)	A	Add Pack	Elect.	Elect.	\$1,800	\$1,040	18	\$286	19	\$103	\$4,916	3.07
Furn. & Bks.	New	Heating	REC	2-SPD-RI	Elect.	Elect.	\$24,128	-\$6,355	1,988	\$7,762	NA	NA	\$73,638	3.05
Pumps/Motors	Old/New	Inc 60 Cell (a)	ASS	Retro All	Elect.	Elect.	\$3,428	-\$967	78	\$1,137	-16.4	-\$90	\$10,345	3.02
Lighting	Old	Heating	B	Furnace C-Old	Elect.	Elect.	\$2,584	\$3,294	25	\$383	21.1	\$116	\$7,736	2.99
Furn. & Bks.	Old	Heating	SHR	Furnace C-Old	Fuel Oil	Nat. Gas (d)	\$42,360	\$9,687	1,635	\$10,518	NA	NA	\$124,533	2.94
Pumps/Motors	New	7 Return Fan	ASS	2-SPD-RI	Elect.	Elect.	\$5,856	-\$1,887	145	\$2,112	-10.9	-\$60	\$20,148	2.84
Lighting	Old/New	Inc 75 Cell (Ext) (a)	C	Retro All	Elect.	Elect.	\$5,162	\$0	235	\$1,166	NA	NA	\$16,892	2.84
Weather.	Old	Heating	ASS	Weather. Pack	Fuel Oil	Fuel Oil	\$1,440	\$0	65	\$323	NA	NA	\$4,012	2.79
Lighting	On	Heating	HGLE	Retro & Sensor	Elect.	Elect.	\$44,744	\$33,994	442	\$7,079	431	\$2,377	\$122,354	2.73
Lighting	Old/New	5d FL 2X4 4-34 STD (b)	B	Retro All	Elect.	Elect.	\$44,744	\$432,588	3,319	\$87,543	0.0	\$0	\$1,218,459	2.73
Lighting	Off	Inc 2X60 Cell (a)	E	Retro All	Fuel Oil	Fuel Oil	\$2,670	\$0	117	\$582	NA	NA	\$7,147	2.68
Weather.	Old	Heating	MED	Weatherstrip	Elect.	Elect.	\$23,864	\$15,575	276	\$4,160	174.6	\$562	\$63,822	2.67
Lighting	Old/New	FL 2X4 4-34 Std (b)	D	Retro Sensor	Fuel Oil	Nat. Gas (d)	\$4,300	\$807	143	\$1,060	NA	NA	\$11,422	2.66
Furn. & Bks.	Old	Heating	OTH	Furnace C New	Elect.	Elect.	\$1,497	-\$465	29	\$456	-6.2	\$34	\$3,971	2.65
Pumps/Motors	New	20 AHU Fan	MED	2-SPD-RI	Elect.	Elect.	\$5,168	\$4,886	46	\$791	36	\$198	\$13,654	2.60
Lighting	Old/New	7a FL 2X4 2-34 STD (b)	A,D	Sensor	Elect.	Elect.	\$54,395	-\$4,124	775	\$10,622	649.0	\$3,576	\$141,345	2.60
Stairlights	Old	Merc Strips	NA	Install HPS 200	Fuel Oil	Nat. Gas (d)	\$24,780	\$4,843	845	\$5,439	NA	NA	\$61,355	2.48
Furn. & Bks	Old	Heating	DGR	Furnace C-Old	Elect.	Elect.	\$511,036	\$502,500	4,597	\$68,034	4,072.8	\$22,441	\$1,265,079	2.48
Lighting	Old/New	Inc 2X75 (a)	A	Retro All	Elect.	Elect.	\$35,250	\$0	421	\$5,959	489.0	\$1,694	\$86,567	2.45
Weather.	On	Heating	RAV	Window Quits	Fuel Oil	Fuel Oil	\$6,942	\$0	285	\$1,419	NA	NA	\$16,994	2.45
Pumps/Motors	Old	Heating	MES	Weatherstrip	Elect.	Elect.	\$638	-\$223	13	\$194	-4.5	\$25	\$1,521	2.38
Pumps/Motors	Old	5 AHU Fan	CLNIC	2-SPD-RI	Elect.	Elect.	\$3,741	-\$1,162	72	\$1,046	-13.8	\$76	\$8,749	2.34
Pumps/Motors	New	7 MP HHCBN	SMA	2-SPD-RI	Elect.	Elect.								

TABLE 3.5. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Exhausting Fuel	Resulting Fuel	Present Value of Installed Cost (1992 \$)	Present Value of O&M Savings (1992 \$)	Annual Energy Savings (MMBtu)	Value Of Energy Savings (1992 \$)	Annual Demand Savings (KW-mo)	Value Of Annual Demand Savings (1992 \$)	Net Present Value of ERO (1992 \$)	Value Index
Pumps/Motors	New	7 MP HHCBN	SHF	2-SPD-RI	Elect.	Elect.	\$8,231	-\$2,557	158	\$2,301	-30.4	-\$168	\$19,244	2.34
Pumps/Motors	Old/New	10 SF2	MED	2-SPD-RI	Elect.	Elect.	\$1,497	-\$465	29	\$418	-6.2	-\$34	\$3,446	2.30
Lighting	New	5f FL 2X4 4-34 STD (b)	B	Retro & Sensor	Elect.	Elect.	\$20,944	\$11,663	157	\$2,699	220	\$1,214	\$45,802	2.19
Lighting	Old/New	FL 2X4 4-40 Std (a)	A	Retro All	Elect.	Elect.	\$886	\$267	9	\$134	8.0	\$44	\$1,882	2.12
Pumps/Motors	New	2 Return Fan	REC	2-SPD-RI	Elect.	Elect.	\$4,584	-\$1,729	81	\$1,175	-7.4	-\$41	\$9,678	2.12
Lighting	On	FL 2X4 4-40 Std (a)	G	Retro All	Elect.	Elect.	\$3,795	\$2,837	100	\$1,477	88.4	\$487	\$20,757	2.12
Pumps/Motors	Old	8 Booster EXH	MED	2-SPD-RI	Elect.	Elect.	\$5,142	-\$1,451	84	\$1,327	-16.4	-\$90	\$10,819	2.10
Furn. & Birs.	New	Lighting	DGR	Furnace C New	Fuel Oil	Net. Gas (d)	\$5,800	\$1,614	156	\$1,163	NA	NA	\$12,166	2.08
Lighting	On	Inc 2X40 (a)	G	Retro All	Elect.	Elect.	\$91,537	\$96,087	670	\$9,923	594.0	\$3,273	\$190,304	2.05
Weather.	Off	Heating	HGCR	Weather. Pack.	Elect.	Elect.	\$12,096	\$0	304	\$2,081	NA	NA	\$24,819	2.05
Furn. & Birs.	Old	Heating	COM	Furnace C-Old	Fuel Oil	Net. Gas (d)	\$7,460	\$1,614	220	\$1,413	0.0	\$0	\$15,270	2.05
Lighting	Off	Inc 60 Cell (a)	E	Retro All	Elect.	Elect.	\$62,505	\$54,598	366	\$9,648	0.0	\$0	\$127,873	2.05
Lighting	Old/New	Inc 2X60 Cell (a)	A	Retro All	Elect.	Elect.	\$234,419	\$230,276	1,743	\$25,791	1,544.0	\$8,507	\$478,675	2.04
Pumps/Motors	New	11 AHU Fan	MED	2-SPD-RI	Elect.	Elect.	\$7,899	-\$1,585	131	\$2,083	-48.2	-\$266	\$16,095	2.04
Lighting	On	Inc 2X60 Cell (a)	G	Retro All	Elect.	Elect.	\$635,305	\$615,549	4,723	\$9,897	4,184.4	\$23,056	\$1,288,740	2.03
Lighting	Old/New	5c FL 2X4 4-34 STD (b)	B	Retro & Sensor	Elect.	Elect.	\$508,640	\$259,635	3,681	\$3,211	4,903	\$27,016	\$1,021,127	2.01
Lighting	Off	Inc 100 Cell (a)	E	Retro All	Elect.	Elect.	\$172,637	\$77,511	1,176	\$31,025	-179.4	\$0	\$341,617	1.98
Pumps/Motors	New	6 Exh Fans	SMA	2-SPD-RI	Elect.	Elect.	\$28,710	-\$10,029	449	\$7,717	-426.4	-\$2,349	\$55,976	1.95
Pumps/Motors	New	6 Exh Fans	SHF	2-SPD-RI	Elect.	Elect.	\$68,266	-\$23,871	1,069	\$18,349	NA	NA	\$133,087	1.95
Furn. & Birs.	Old	Heating	COM	Boiler P-Old	Fuel Oil	Net. Gas (d)	\$7,580	\$807	213	\$1,471	NA	NA	\$14,574	1.92
Furn. & Birs.	Old	Heating	CLB	Boiler P-Old	Fuel Oil	Net. Gas (d)	\$15,160	\$1,614	376	\$3,119	NA	NA	\$28,499	1.88
Lighting	Old/New	5e FL 2X4 4-34 STD (b)	A/B	Retro & Sensor	Elect.	Elect.	\$8,160	\$3,972	55	\$952	79	\$433	\$15,311	1.88
Pumps/Motors	New	8 Supply Fan	REC	2-SPD-RI	Elect.	Elect.	\$4,564	-\$1,729	81	\$1,175	-22.2	-\$122	\$8,530	1.87
Pumps/Motors	Old	1 Lift Pump Motor	SEWER	Effic.-ROF	Elect.	Elect.	\$1,250	-\$758	14	\$197	7.0	\$35	\$2,332	1.86
Lighting	Old/New	Ext. 2xPL9 (a)	A	Retro All	Elect.	Elect.	\$70,000	\$123,872	314	\$4,581	126.0	\$694	\$128,126	1.83
Weather.	Old	Heating	ADM	Weatherstrip	Fuel Oil	Fuel Oil	\$39,338	\$0	1,317	\$6,549	NA	NA	\$71,159	1.81
Lighting	Off	FL 2X4 4-40 Std (a)	E	Retro All	Elect.	Elect.	\$11,712	\$6,957	213	\$5,616	0.0	\$0	\$55,280	1.80
Weather.	Off	Heating	HGWC	Weather. Pack.	Elect.	Net. Gas (a)	\$1,732	\$0	261	\$1,768	NA	NA	\$19,954	1.80
Furn. & Birs.	Old	Heating	OTH	Furnace C-Old	Fuel Oil	Net. Gas (d)	\$7,460	\$1,614	193	\$1,241	NA	NA	\$12,701	1.70
Pumps/Motors	New	7 EXH Fan	REC	Furnace C-Old	Elect.	Elect.	\$1,232	-\$4,971	185	\$3,185	-63.8	-\$352	\$21,793	1.66
Controls	Old	Hot Water	REC	FM System	Fuel Oil	Fuel Oil	\$6,231	\$0	39	\$192	NA	NA	\$2,006	1.63
Lighting	On	Inc 60 Well (a)	G	Retro All	Elect.	Elect.	\$8,1736	\$2,422	119	\$1,064	NA	NA	\$10,141	1.63
Lighting	Old/New	FL 2X4 4-34 Std (a)	A	Retro All	Elect.	Elect.	\$410,600	\$73,530	508	\$7,522	450.3	\$2,481	\$132,607	1.62
Pumps/Motors	New	9 MAHU	SMA	2-SPD-RI	Elect.	Elect.	\$20,416	-\$7,139	3,373	\$49,921	2,988.5	\$16,466	\$682,733	1.61
Pumps/Motors	Old	Heating	MES	2-SPD-RI	Elect.	Elect.	\$8,294	-\$2,900	130	\$2,061	-58.3	-\$321	\$32,728	1.60
Furn. & Birs.	Old	Heating	HGAR	Furnace C-Old	Fuel Oil	Net. Gas (d)	\$80,990	\$13,723	1,230	\$7,911	NA	NA	\$80,978	1.59
Lighting	On	Inc 150 Cell (a)	G	Weather. Pack.	Elect.	Net. Gas (e)	\$24,576	\$0	524	\$3,552	253.9	\$1,359	\$39,029	1.59
Pumps/Motors	Old/New	Inc 150 Cell (a)	SEWER	Retro All	Elect.	Elect.	\$31,858	\$2,520	287	\$4,241	NA	NA	\$50,080	1.57
Lighting	On	Inc 60 Cell (a)	A	2-SPD-RI	Elect.	Elect.	\$5,218	-\$244	13	\$181	1.7	\$9	\$1,485	1.57
Furn. & Birs.	Old/New	Inc 200 Susp (a)	B	Retro All	Elect.	Elect.	\$11,890	\$2,422	47	\$695	41.6	\$229	\$8,177	1.57
Lighting	On	Heating	CLB	Furnace C-Old	Fuel Oil	Net. Gas (d)	\$227,018	\$198,298	290	\$1,865	NA	NA	\$18,403	1.55
Furn. & Birs.	Old	Heating	G	Retro All	Elect.	Elect.	\$59,496	-\$16,363	1,328	\$19,657	1,176.8	\$6,484	\$339,270	1.49
Furn. & Birs.	Old	Heating	SHF	Furnace C New	Fuel Oil	Net. Gas (d)	\$55,900	\$11,301	1,212	\$9,011	NA	NA	\$82,137	1.47
Furn. & Birs.	Old	Heating	HGEM	Boiler P-New	Fuel Oil	Net. Gas (e)	\$45,480	\$3,229	990	\$7,954	NA	NA	\$66,246	1.46
Weather.	Off	Heating	REC	Weather. Pack.	Fuel Oil	Net. Gas (d)	\$28,800	\$0	577	\$3,912	NA	NA	\$41,264	1.43
Furn. & Birs.	Old	Heating	BAR	Furnace C-Old	Fuel Oil	Net. Gas (d)	\$173,780	\$32,289	4,004	\$25,764	NA	NA	\$243,585	1.40
Furn. & Birs.	Old	Heating	REC	Furnace C-Old	Fuel Oil	Net. Gas (d)	\$4,430	\$807	102	\$656	NA	NA	\$6,152	1.40
Furn. & Birs.	Old	Heating	HGCB	Weather. Pack.	Fuel Oil	Net. Gas (e)	\$14,504	\$0	420	\$2,850	NA	NA	\$19,528	1.37
Weather.	Off	Heating	HGCA	Weather. Pack.	Net. Gas (e)	Net. Gas (e)	\$8,544	\$0	281	\$1,903	NA	NA	\$19,682	1.37
Weather.	On	Heating	HGBO	Weather. Pack.	Net. Gas (d)	Net. Gas (d)	\$8,702	\$3,910	253	\$1,121	NA	NA	\$11,528	1.35
Lighting	Old/New	Inc 100 Cell (a)	A	Retro All	Elect.	Elect.	\$1,276	-\$446	59	\$878	52.6	\$250	\$11,641	1.34
Pumps/Motors	New	15 AHU Fan	MED	2-SPD-RI	Elect.	Elect.	\$1,276	-\$446	20	\$291	-9.0	-\$50	\$1,677	1.31
Pumps/Motors	Old	8 Dom. Wtr Htr	DGR	Effic.-RI	Elect.	Elect.	\$455	\$23	4	\$52	4.0	\$22	\$602	1.31
Furn. & Birs.	Old	Heating	SHF	Boiler P-Old	Fuel Oil	Net. Gas (d)	\$113,700	\$12,108	2,485	\$17,121	NA	NA	\$146,887	1.29

TABLE 3.5. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1992 \$)	Present Value of O&M (1992 \$)	Annual Energy Savings (MMBtu)	Value Of Annual Energy Savings (1992 \$)	Annual Demand Savings (KW-mo)	Value Of Annual Demand Savings (1992 \$)	Net Present Value of ERO (1992 \$)	Value Index
Lighting	Old/New	FL 2X4 2-34 Std (b)	A	Sensor	Elect.	Elect.	\$17,607	\$8,211	110	\$1,626	117.9	\$649	\$22,635	1.29 (c)
Lighting	Old/New	FL 2X4 2-34 Std (a)	A	Sensor	Elect.	Elect.	\$0	\$0	0	\$0	0.0	\$0	\$0	1.29 (c)
Lighting	Old/New	FL 1X4 2-34 Std (a)	A	Sensor	Elect.	Elect.	\$0	\$0	0	\$0	0.0	\$0	\$0	1.29 (c)
Furn. & Bfrs.	Old	Heating	MED	Furnace C-Old	Fuel Oil	Nat. Gas (d)	\$7,047	\$3,286	44	\$651	47.2	\$260	\$9,060	1.29 (c)
Weather.	Off	Heating	HGAC	Weather. Pack.	Nat. Gas (e)	Nat. Gas (e)	\$20,750	\$4,036	448	\$2,881	NA	NA	\$26,344	1.27
Weather.	On	Heating	HGLE	Window Quilt	Fuel Oil	Fuel Oil	\$11,520	\$0	214	\$1,451	NA	NA	\$14,471	1.26
Weather.	On	Heating	HGCA	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$11,250	\$0	302	\$1,501	NA	NA	\$14,078	1.25
Pumps & Motors	New	AHU Fan	ADM	CO2 Sensor	Elect.	Elect.	\$14,400	\$0	407	\$1,804	NA	NA	\$17,908	1.24
Lighting	Off	Inc 60 Bare (a)	E	Retro All	Elect.	Elect.	\$28,215	-\$87,292	1,526	\$9,555	0.0	\$0	\$33,752	1.20
Weather.	Off	Inc 60 Cell (a)	E	Retro All	Elect.	Elect.	\$69,199	\$41,796	297	\$7,826	0.0	\$0	\$82,761	1.20
Weather.	Off	Heating	HGCB	Weather. Pack.	Elect.	Elect.	\$62,262	\$37,806	267	\$7,041	0.0	\$0	\$74,464	1.20
Lighting	Old/New	FL 5X4 1-40 Std (a)	C	Retro All	Elect.	Elect.	\$14,400	\$0	259	\$1,758	NA	NA	\$17,088	1.19
Weather.	On	Heating	C	Retro All	Elect.	Elect.	\$62,991	\$15,467	454	\$7,077	284.9	\$1,570	\$74,198	1.18
Furn. & Bfrs.	Old	Heating	HGSA	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$96,565	\$23,711	696	\$10,849	436.8	\$2,407	\$113,744	1.17
Pumps & Motors	New	12 Return Fan	LAU	Boiler P-Old	Fuel Oil	Nat. Gas (d)	\$9,600	\$0	262	\$1,161	NA	NA	\$11,188	1.17
Weather.	On	Heating	MED	2-SPD-RI	Elect.	Elect.	\$7,580	\$807	155	\$1,068	NA	NA	\$8,721	1.15
Furn. & Bfrs.	Old	Heating	ADM	Furnace C-Old	Fuel Oil	Nat. Gas (d)	\$1,276	-\$446	17	\$243	-3.0	-\$17	\$1,460	1.14
Weather.	On	Heating	RAV	Ceiling Insulation-40	Elect.	Elect.	\$28,600	\$0	4,461	\$28,701	NA	NA	\$255,022	1.14
Weather.	On	Heating	HGCL	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$17,472	\$0	251	\$3,808	94.0	\$518	\$32,293	1.13
Weather.	On	Heating	HGLI	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$20,928	\$0	460	\$2,036	NA	NA	\$18,996	1.09
Furn. & Bfrs.	Old	Hot Water	HOT	New DWI	Fuel Oil	Nat. Gas (d)	\$807	\$807	547	\$2,425	NA	NA	\$22,500	1.08
Weather.	Old	Heating	LAU	Furnace C-Old	Fuel Oil	Nat. Gas (d)	\$4,430	\$807	30	\$265	NA	NA	\$2,209	1.06
Weather.	Old	Heating	SHP	Floor Ins.	Fuel Oil	Fuel Oil	\$12,533	\$0	85	\$549	NA	NA	\$4,587	1.04
Weather.	On	Heating	HGWI	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$7,880	\$0	304	\$1,510	NA	NA	\$12,950	1.03
Weather.	On	Heating	OTH	Floor Ins.	Fuel Oil	Fuel Oil	\$474	\$0	196	\$869	NA	NA	\$17,882	1.03
Weather.	On	Heating	HGCL	Weather. Pack.	Propane	Propane	\$9,600	\$0	205	\$1,235	NA	NA	\$4,774	1.00
Hot Water	Old	Hot Water	SIM	New DWI	Fuel Oil	Nat. Gas (d)	\$2,077	\$807	28	\$250	NA	NA	\$2,012	0.97
Weather.	Old	Heating	SIM	Floor Ins.	Fuel Oil	Fuel Oil	\$515	\$0	12	\$60	NA	NA	\$497	0.97
Pumps/Motors	New	14 Wtr Pmp Ccnd	MED	2-SPD-RI	Elect.	Elect.	\$1,914	-\$669	25	\$364	-9.0	-\$50	\$1,841	0.96
Weather.	On	Heating	HGPA	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$7,200	\$0	178	\$788	NA	NA	\$6,906	0.96
Weather.	On	Heating	HGRE	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$18,048	\$0	445	\$1,971	NA	NA	\$17,243	0.96
Weather.	Off	Heating	HGLO	Weather. Pack.	Propane	Propane	\$5,376	\$0	114	\$685	NA	NA	\$5,119	0.95
Furn. & Bfrs.	Off	Heating	HGEB	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$15,232	\$0	244	\$1,652	NA	NA	\$14,348	0.94
Pumps/Motors	New	7 Sup Wtr Pmp	BAR	2-SPD-RI	Elect.	Elect.	\$24,591	-\$8,982	290	\$4,224	-35.5	-\$196	\$23,129	0.94
Furn. & Bfrs.	Off	Heating	HGCA	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$10,200	\$0	163	\$1,102	NA	NA	\$9,538	0.94
Furn. & Bfrs.	Off	Heating	HGCR	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$8,568	\$0	136	\$925	NA	NA	\$8,001	0.93
Furn. & Bfrs.	Off	Heating	HGAR	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$17,408	\$0	276	\$1,868	NA	NA	\$16,048	0.92
Weather.	Old	Heating	CLB	Floor Ins.	Fuel Oil	Fuel Oil	\$1,247	\$0	28	\$141	NA	NA	\$1,140	0.91
Weather.	Off	Heating	HGGC	Weather. Pack.	Propane	Propane	\$7,200	\$0	149	\$898	NA	NA	\$6,562	0.91
Weather.	On	Heating	MTH	Weatherstrip	Fuel Oil	Fuel Oil	\$1,245	\$0	28	\$141	NA	NA	\$1,132	0.91
Furn. & Bfrs.	On	Heating	HGRH	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$22,272	\$0	530	\$2,349	NA	NA	\$19,799	0.89
Lighting	Old/New	FL 2X4 3-34 Std (b)	HGEM	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$20,400	\$0	317	\$2,160	NA	NA	\$18,098	0.89
Lighting	Old/New	FL 2X4 3-34 Std (a)	D	Retro/Sensor	Elect.	Elect.	\$34,253	\$34,253	576	\$8,684	36E.8	\$2,016	\$86,676	0.86 (c)
Weather.	Old	Heating	WAR	Weatherstrip	Fuel Oil	Fuel Oil	\$26,815	\$8,455	150	\$2,262	94.0	\$518	\$20,773	0.86 (c)
Furn. & Bfrs.	Off	Heating	HGWC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$18,156	\$0	402	\$1,999	NA	NA	\$15,572	0.86
Hot Water	Old	Hot Water	ASS	New DWI	Fuel Oil	Nat. Gas (d)	\$18,653	\$7,265	233	\$2,083	NA	NA	\$15,889	0.85
Weather.	Off	Heating	HGHN	Weather. Pack.	Propane	Propane	\$5,216	\$0	184	\$1,110	NA	NA	\$7,796	0.85
Weather.	Old	Heating	DGR	Window Quilt	Fuel Oil	Fuel Oil	\$2,138	\$0	47	\$234	NA	NA	\$1,804	0.84
Furn. & Bfrs.	Old	Heating	HGCR	Boiler P New	Nat. Gas (d)	Nat. Gas (d)	\$15,160	\$1,614	239	\$1,920	NA	NA	\$12,639	0.83
Weather.	Off	Heating	SIM	Weather. Pack.	Elect.	Elect.	\$94,500	\$0	1,419	\$9,619	NA	NA	\$77,770	0.82
Lighting	Old/New	7c FL 2X4 2-34 STD (b)	HGCU	Sensor	Nat. Gas (d)	Nat. Gas (d)	\$29,952	\$771	7	\$125	6	\$31	\$1,340	0.82
Weather.	On	Heating	HGSO	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$15,552	\$0	355	\$3,029	NA	NA	\$24,300	0.81
Weather.	On	Heating	HGYO	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$15,552	\$0	355	\$1,573	NA	NA	\$12,617	0.81
Weather.	On	Heating	HGAD	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$18,528	\$0	422	\$1,865	NA	NA	\$14,945	0.81

TABLE 3.5. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1992 \$)	Present Value of O&M Savings (1992 \$)	Annual Energy Savings (MMBtu)	Value Of Annual Energy Savings (1992 \$)	Annual Demand Savings (KW-mo)	Value Of Annual Demand Savings (1992 \$)	Net Present Value of ERO (1992 \$)	Value Index
Weather.	On	Heating	HGSL	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$18,048	\$0	410	\$1,816	NA	NA	\$14,475	0.80
Pumps/Motors	Old	2 Chill Supply	CLNIC	2-SPD-RI	Elect.	Elect.	\$1,276	-\$446	13	\$211	-3.0	-17	\$1,021	0.80
Lighting	Old/New	FL 1X8 2-96 Std (a)	B	Retro All	Elect.	Elect.	\$57,470	\$18,195	300	\$4,619	254.5	\$1,402	\$45,482	0.79
Furn. & Bfs.	Off	Heating	HGCB	Flus Demper	Nat. Gas (e)	Nat. Gas (e)	\$10,200	\$0	150	\$1,018	NA	NA	\$9,036	0.79
Pumps/Motors	New	5 SMF Fans	SHP	2-SPD-RI	Elect.	Elect.	\$11,981	-\$4,539	148	\$2,160	-58.3	-138	\$9,360	0.78
Pumps/Motors	New	5 SMF Fans	SMA	2-SPD-RI	Elect.	Elect.	\$5,135	-\$1,945	64	\$928	-25.0	-138	\$4,009	0.78
Furn. & Bfs.	Old	Heating	CLD	Boiler P New	Fuel Oil	Nat. Gas (d)	\$15,160	\$1,614	231	\$1,858	NA	NA	\$11,784	0.78
Lighting	Old/New	Inc 100 Susp (a)	B	Retro All	Elect.	Elect.	\$1,509	-\$793	12	\$189	10.4	\$57	\$1,173	0.78
Lighting	Old/New	FL 2X4 2-34 STD (b)	A, B	Sensor	Elect.	Elect.	\$29,230	\$14,424	143	\$2,243	75	\$413	\$22,577	0.77
Furn. & Bfs.	Old	Heating	MED	Furnace C New	Fuel Oil	Nat. Gas (d)	\$25,800	\$4,843	389	\$2,893	NA	NA	\$19,731	0.76
Furn. & Bfs.	Old	Heating	BAR	Boiler P New	Fuel Oil	Nat. Gas (d)	\$68,220	\$7,265	1,027	\$6,258	NA	NA	\$51,681	0.76
Weather.	Old	Heating	OTH	Weatherstrip	Fuel Oil	Fuel Oil	\$1,780	\$0	7	\$185	NA	NA	\$1,347	0.76
Pumps/Motors	Old	7 Lift Pump Motor	SEWER	2-SPD-RI	Elect.	Elect.	\$701	-\$225	7	\$99	0.8	\$4	\$529	0.76
Lighting	Old/New	FL 1X4 2-34 Std WP (a)	D	Retro&Sensor	Elect.	Elect.	\$44,407	\$14,058	231	\$3,483	144.7	\$797	\$29,505	0.75 (c)
Lighting	Old/New	FL 1X4 2-34 Std WP (b)	D	Retro&Sensor	Elect.	Elect.	\$148,945	\$53,347	808	\$12,175	511.3	\$2,817	\$115,441	0.75 (c)
Furn. & Bfs.	Off	Heating	HGAC	Flus Demper	Nat. Gas (e)	Nat. Gas (e)	\$8,160	\$0	118	\$797	NA	NA	\$6,121	0.75
Lighting	Old/New	6d FL 2X4 3-34 STD (b)	D	Retro & Sensor	Elect.	Elect.	\$5,352	\$2,054	24	\$391	23	\$124	\$3,953	0.74
Furn. & Bfs.	Old	Heating	BAR	Boiler P-Old	Fuel Oil	Nat. Gas (d)	\$45,480	\$4,843	741	\$5,104	NA	NA	\$33,440	0.74
Weather.	Old	Heating	MES	Window Quilt	Fuel Oil	Fuel Oil	\$14,173	\$0	290	\$1,442	NA	NA	\$10,157	0.72
Furn. & Bfs.	Old	Heating	BAR	Furnace C New	Fuel Oil	Nat. Gas (d)	\$67,100	\$129,963	9,663	\$71,856	NA	NA	\$473,442	0.71
Furn. & Bfs.	Old	Heating	ASS	Furnace C New	Fuel Oil	Nat. Gas (d)	\$48,800	\$9,687	704	\$5,238	NA	NA	\$34,556	0.71
Pumps/Motors	New	10 Prim Pump	ASS	2-SPD-RI	Elect.	Elect.	\$2,552	-\$892	35	\$505	-23.9	-132	\$1,804	0.71
Lighting	Old/New	Inc 75 Ceil (a)	A	Retro All	Elect.	Elect.	\$156,926	\$70,457	708	\$10,478	627.3	\$3,456	\$109,688	0.70
Hot Water	Old	10 Vac Pump	CLNIC	Retro DWH	Fuel Oil	Nat. Gas (d)	\$378,014	\$146,914	4,188	\$37,436	NA	NA	\$253,731	0.69
Pumps/Motors	Old	10 Vac Pump	CLNIC	Effic.-ROF	Elect.	Elect.	\$573	-\$90	5	\$41	2.7	\$8	\$339	0.68
Furn. & Bfs.	Old	Heating	ASS	Furnace C-Old	Fuel Oil	Nat. Gas (d)	\$18,050	\$4,843	285	\$1,703	NA	NA	\$12,246	0.68
Hot Water	On	Hot Water	HGLE	Retro DWH	Fuel Oil	Nat. Gas (d)	\$10,215	\$12,108	26	\$432	NA	NA	\$6,614	0.65
Pumps/Motors	New	1 Ref Comp	GRO	Effic.-ROF	Elect.	Elect.	\$7,275	-\$1,111	59	\$469	37.8	\$113	\$4,605	0.63
Weather.	Off	Heating	HGCO	Weather. Pack.	Propane	Propane	\$7,200	\$0	127	\$764	NA	NA	\$4,518	0.63
Weather.	Off	Heating	HGWC	Window Quilt	Nat. Gas (e)	Nat. Gas (e)	\$91,500	\$0	1,217	\$8,252	NA	NA	\$56,276	0.62
Lighting	Old/New	FL 5X4 2-40 Std (a)	B	Retro All	Elect.	Elect.	\$25,680	\$6,219	120	\$1,850	101.9	\$562	\$14,486	0.56
Lighting	Old/New	FL 1X4 2-40 Std (a)	B	Retro All	Elect.	Elect.	\$240,240	\$58,178	1,123	\$17,306	953.5	\$5,254	\$135,518	0.56
Furn. & Bfs.	On	Heating	HGLE	Window Quilt	Fuel Oil	Nat. Gas (e)	\$28,500	\$12,108	280	\$2,409	NA	NA	\$13,655	0.55
Weather.	Off	Heating	HGAR	Furn-C	Nat. Gas (e)	Nat. Gas (e)	\$192,000	\$0	2,445	\$16,574	NA	NA	\$104,823	0.55
Pumps/Motors	New	3 Chiller	DGR	Effic.-ROF	Elect.	Elect.	\$3,155	-\$475	23	\$181	14.0	\$42	\$1,717	0.54
Pumps/Motors	New	2 Chiller	DGR	Effic.-ROF	Elect.	Elect.	\$2,621	-\$406	19	\$151	11.8	\$36	\$1,425	0.54
Lighting	Old/New	Mec 100 (a)	C	Retro All	Elect.	Elect.	\$19,890	\$134	113	\$1,759	70.8	\$390	\$10,492	0.53
Pumps/Motors	Old	8 Lift Pump Motor	SEWER	2-SPD-RI	Elect.	Elect.	\$701	-\$225	6	\$87	0.8	\$4	\$366	0.52
Lighting	Old/New	Inc 150 Susp (a)	B	Retro All	Elect.	Elect.	\$121,971	-\$84,908	956	\$14,740	812.1	\$4,475	\$63,609	0.52
Pumps/Motors	New	1 HW Pump	SHP	Effic.-ROF	Elect.	Elect.	\$13,081	-\$1,395	81	\$647	56.0	\$169	\$6,615	0.51
Pumps/Motors	New	1 HW Pump	SMA	Effic.-ROF	Elect.	Elect.	\$5,579	-\$595	35	\$276	23.8	\$72	\$2,819	0.51
Hot Water	Off	Hot Water	HGCL	Flus Demper	Propane	Propane	\$6,800	\$0	109	\$658	NA	NA	\$3,294	0.48
Lighting	Off	FL 5X4 2-40 Std (a)	E	Retro All	Elect.	Elect.	\$91,246	\$19,409	311	\$8,205	0.0	\$0	\$43,667	0.48
Hot Water	Off	Hot Water	HGLO	Flus Demper	Propane	Propane	\$3,808	\$0	61	\$365	NA	NA	\$1,789	0.47
Furn. & Bfs.	Old	Heating	HOT	Boiler P New	Fuel Oil	Nat. Gas (d)	\$7,580	\$807	94	\$755	NA	NA	\$3,522	0.46
Pumps/Motors	Old	9 Vac Pump	CLNIC	Effic.-ROF	Elect.	Elect.	\$535	-\$92	4	\$28	2.1	\$6	\$248	0.46
Lighting	Old/New	FL 1X4 2-34 Std (a)	B	Retro&Sensor	Elect.	Elect.	\$49,014	\$23,636	166	\$2,562	141.2	\$778	\$21,638	0.46 (c)
Lighting	Old/New	FL 1X4 2-34 Std (b)	B	Retro&Sensor	Elect.	Elect.	\$13,801	\$5,973	51	\$781	56.2	\$309	\$7,422	0.46 (c)
Weather.	Old	Heating	COM	Floor Ins.	Fuel Oil	Fuel Oil	\$1,036	\$0	18	\$89	NA	NA	\$474	0.46
Furn. & Bfs.	Old	Heating	MES	Furnace C New	Fuel Oil	Nat. Gas (d)	\$81,700	\$15,337	989	\$7,354	NA	NA	\$37,066	0.45
Weather.	Off	Heating	HGEM	Window Quilt	Nat. Gas (e)	Nat. Gas (e)	\$225,000	\$0	2,893	\$18,257	NA	NA	\$101,964	0.45
Lighting	Old/New	FL 2X4 3-40 Std (a)	A	Sensor	Elect.	Elect.	\$0	\$0	0	\$0	0.0	\$0	\$0	0.44 (c)
Lighting	Old/New	FL 2X4 3-40 Std (b)	A	Sensor	Elect.	Elect.	\$784	\$172	3	\$49	3.5	\$15	\$347	0.44 (c)
Hot Water	Off	Hot Water	HGGC	Flus Demper	Propane	Propane	\$5,100	\$0	80	\$479	NA	NA	\$2,240	0.44
Furn. & Bfs.	Old	Heating	WAR	Furnace C-Old	Fuel Oil	Nat. Gas (d)	\$122,130	\$25,024	1,562	\$10,051	NA	NA	\$53,115	0.43
Lighting	Old/New	FL 2X4 2-34 Std (a)	D	Retro All	Elect.	Elect.	\$9,072	\$4,164	34	\$511	21.2	\$117	\$3,929	0.43

TABLE 3.5. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1992 \$)	Present Value of O&M Savings (1992 \$)	Annual Energy Savings (MMBtu)	Value Of Annual Energy Savings (1992 \$)	Annual Demand Savings (KW-mo)	Value Of Annual Demand Savings (1992 \$)	Net Present Value of ERO (1992 \$)	Value Index
Hot Water	Old	Hot Water	MED	New DWH	Fuel Oil	Nat. Gas (d)	\$22,847	\$8,879	202	\$1,802	NA	NA	\$9,664	0.42
Weather.	Off	Heating	HGEB	Window Quilt	Nat. Gas (e)	Nat. Gas (e)	\$168,000	\$0	1,961	\$13,298	NA	NA	\$70,151	0.42
Weather.	Off	Heating	HGCA	Window Quilt	Nat. Gas (e)	Nat. Gas (e)	\$112,500	\$0	1,310	\$8,881	NA	NA	\$46,548	0.41
Weather.	Old	Heating	ADAM	Floor Ins.	Fuel Oil	Fuel Oil	\$23,807	\$0	359	\$1,984	NA	NA	\$9,674	0.41
Weather.	Old	Heating	ASS	Floor Ins.	Fuel Oil	Fuel Oil	\$4,239	\$0	71	\$353	NA	NA	\$1,723	0.41
Weather.	Old	Heating	MED	Floor Ins.	Fuel Oil	Fuel Oil	\$2,115	\$0	35	\$176	NA	NA	\$853	0.41
Weather.	On	Heating	HGBO	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$66,750	\$0	1,181	\$5,230	NA	NA	\$26,920	0.40
Lighting	Old/New	FL 1X4 1-40 Std (a)	B	Retro All	Elect.	Elect.	\$944	\$314	4	\$56	3.0	\$17	\$377	0.40
Hot Water	On	Hot Water	HGBO	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$6,052	\$0	107	\$472	NA	NA	\$2,399	0.40
Hot Water	Off	Hot Water	HGGN	Fus Dampers	Propane	Propane	\$6,528	\$0	98	\$592	NA	NA	\$2,545	0.39
Lighting	Old/New	FL 5X4 1-34 Std (a)	B	Retro All	Elect.	Elect.	\$3,400	\$1,215	12	\$188	10.3	\$57	\$1,260	0.37
Pumps/Motors	New	2 AHU Fan	ADM	Effic.-ROF	Elect.	Elect.	\$10,400	-\$1,049	40	\$318	59.1	\$178	\$3,818	0.37
Weather.	Old	Heating	REC	Floor Ins.	Fuel Oil	Fuel Oil	\$2,080	\$0	34	\$167	NA	NA	\$739	0.36
Pumps/Motors	New	4 Exh Fans	SHP	2-SPD-ROF	Elect.	Elect.	\$21,844	-\$13,504	265	\$2,486	-108.2	-\$326	\$7,720	0.35
Pumps/Motors	New	4 Exh Fans	SMA	2-SPD-ROF	Elect.	Elect.	\$9,216	-\$5,897	112	\$1,049	-45.7	-\$138	\$3,255	0.35
Pumps/Motors	New	16 Supply Pmp	MED	Effic.-ROF	Elect.	Elect.	\$9,553	-\$63	2	\$14	4.1	\$12	\$194	0.35
Weather.	Off	Heating	HGAC	Window Quilt	Nat. Gas (e)	Nat. Gas (e)	\$90,000	\$0	999	\$6,773	NA	NA	\$31,292	0.35
Lighting	Old/New	FL 2X4 3-34 Std (b)	B	Retro Sensor	Elect.	Elect.	\$912,461	\$254,567	3,459	\$52,710	3,300.8	\$18,187	\$340,122	0.35
Lighting	Old/New	FL 2X4 3-34 Std (a)	B	Retro Sensor	Elect.	Elect.	\$284,460	\$71,252	925	\$14,256	785.4	\$4,328	\$88,395	0.35
Weather.	On	Heating	HGCA	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$112,500	\$0	1,900	\$8,419	NA	NA	\$38,275	0.34
Pumps/Motors	Old	5 Lift Pump Motor	SEWER	2-SPD-ROF	Elect.	Elect.	\$403	-\$239	5	\$37	0.4	\$1	\$138	0.34
Hot Water	On	Hot Water	HGCA	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$10,200	\$0	171	\$760	NA	NA	\$3,404	0.33
Pumps/Motors	Old	8 Chiller Comp	CLNIC	Effic.-ROF	Elect.	Elect.	\$1,277	-\$196	5	\$44	6.3	\$19	\$421	0.33
Pumps/Motors	Old	7 Chiller Comp	CLNIC	Effic.-ROF	Elect.	Elect.	\$506	-\$79	2	\$17	2.3	\$7	\$161	0.32
Pumps/Motors	Old	4 AHU Fan	CLNIC	2-SPD-ROF	Elect.	Elect.	\$586	-\$214	6	\$80	-1.9	-\$10	\$185	0.32
Pumps/Motors	New	1 AHU Fan	ADM	Effic.-ROF	Elect.	Elect.	\$10,400	-\$1,049	32	\$254	59.1	\$178	\$3,194	0.31
Weather.	Off	Heating	HGCB	Window Quilt	Nat. Gas (e)	Nat. Gas (e)	\$112,500	\$0	1,210	\$8,205	NA	NA	\$34,442	0.31
Weather.	On	Heating	HGSA	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$75,000	\$0	1,223	\$5,417	NA	NA	\$22,011	0.29
Hot Water	On	Hot Water	HGSA	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$6,800	\$0	110	\$489	NA	NA	\$1,953	0.29
Weather.	Old	Heating	SHP	Ceiling Ins.	Fuel Oil	Fuel Oil	\$42,111	\$0	646	\$3,210	NA	NA	\$12,051	0.29
Weather.	Old	Heating	OTH	Ceiling Ins.	Fuel Oil	Fuel Oil	\$1,592	\$0	24	\$119	NA	NA	\$421	0.26
AC	Old/New	11 Lift Pump Motor	NA	Com. WAC-1.2/10	Elect.	Elect.	\$31,850	\$0	86	\$1,470	225.2	\$1,241	\$8,393	0.26
Pumps/Motors	Old	3 Supply Fan	SEWER	2-SPD-ROF	Elect.	Elect.	\$409	-\$239	5	\$34	0.5	\$2	\$105	0.26
Pumps/Motors	New	3 Air Comp	BAR	Effic.-ROF	Elect.	Elect.	\$14,494	-\$1,414	40	\$321	64.6	\$195	\$3,654	0.25
Pumps/Motors	New	3 Air Comp	SHP	Effic.-ROF	Elect.	Elect.	\$4,796	-\$752	14	\$122	25.3	\$76	\$1,199	0.25
Weather.	On	Heating	HGCL	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$136,500	\$0	2,145	\$9,503	NA	NA	\$33,682	0.25
Hot Water	On	Hot Water	HGCL	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$12,376	\$0	194	\$857	NA	NA	\$2,979	0.24
Weather.	On	Heating	HGLI	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$163,500	\$0	2,555	\$11,317	NA	NA	\$39,165	0.24
Pumps/Motors	New	3 Air Comp	SMA	Effic.-ROF	Elect.	Elect.	\$2,180	-\$342	6	\$52	11.6	\$35	\$514	0.24
Hot Water	On	Hot Water	HGLI	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$14,824	\$0	230	\$1,021	NA	NA	\$3,462	0.23
Pumps/Motors	New	11 HW Pumps	ADM	Effic.-ROF	Elect.	Elect.	\$22,122	-\$2,359	59	\$469	94.5	\$285	\$5,041	0.23
Hot Water	Off	Hot Water	HGCO	Fus Dampers	Propane	Propane	\$5,100	\$0	68	\$408	NA	NA	\$1,149	0.23
Furn. & Bfs.	Old	Heating	ADM	Furnace C New	Fuel Oil	Nat. Gas (d)	\$452,300	\$102,517	4,301	\$31,987	NA	NA	\$100,074	0.22
Weather.	Old	Heating	CLB	Floor Ins.	Fuel Oil	Fuel Oil	\$38,749	\$0	564	\$2,802	NA	NA	\$8,523	0.22
Weather.	Old	Heating	CLB	Ceiling Ins.	Fuel Oil	Fuel Oil	\$4,189	\$0	60	\$301	NA	NA	\$885	0.21
Weather.	On	Heating	HGWI	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$60,000	\$0	915	\$4,055	NA	NA	\$12,622	0.21
Hot Water	On	Hot Water	HGWI	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$5,440	\$0	83	\$366	NA	NA	\$1,112	0.20
Pumps/Motors	New	18 Ref Comp	MES	Effic.-ROF	Elect.	Elect.	\$3,832	-\$387	12	\$94	7.3	\$22	\$749	0.20
Pumps/Motors	Old	18 Ref Comp	CLB	Effic.-ROF	Elect.	Elect.	\$1,642	-\$165	5	\$40	3.1	\$5	\$320	0.19
Furn. & Bfs.	Old	Heating	ASS	Boiler E-Old	Fuel Oil	Nat. Gas (d)	\$34,560	\$4,943	95	\$2,708	NA	NA	\$6,301	0.18
Weather.	Off	Heating	HGCL	Window Quilt	Propane	Propane	\$56,250	\$0	830	\$5,761	NA	NA	\$13,325	0.18
Weather.	On	Heating	HGPA	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$30	\$0	830	\$3,676	NA	NA	\$9,579	0.17
Weather.	On	Heating	HGRE	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$141,000	\$0	2,076	\$13,196	NA	NA	\$23,691	0.17
Weather.	Off	Heating	HGLO	Window Quilt	Propane	Propane	\$42,000	\$0	531	\$3,195	NA	NA	\$6,977	0.17
Hot Water	On	Hot Water	HGPA	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$5,100	\$0	75	\$332	NA	NA	\$839	0.16
Hot Water	On	Hot Water	HGRE	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$12,784	\$0	187	\$830	NA	NA	\$2,075	0.16

TABLE 3.5. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1992 \$)	Present Value of O&M Savings (1992 \$)	Annual Energy Savings (MMBtu)	Value of Annual Energy Savings (1992 \$)	Annual Demand Savings (kW-mo)	Value of Annual Demand Savings (1992 \$)	Net Present Value of ERO (1992 \$)	Value Index
Hot Water	Old	Hot Water	MES	New DWH	Propane	Nat. Gas (d)	\$41,540	\$0	256	\$4,525	NA	NA	\$6,338	0.15
Pump/Motors	New	19 Pump	CLB	Effic.-ROF	Elect.	Elect.	\$518	-\$50	1	\$10	0.8	\$2	\$76	0.15
Pump/Motors	New	18 Air Comp	MED	Effic.-ROF	Elect.	Elect.	\$1,518	-\$237	3	\$26	6.8	\$20	\$221	0.15
Weather.	Off	Heating	HGHC	Window Quilt	Propane	Propane	\$6,260	-\$118	3	\$24	1.8	\$5	\$175	0.14
Pump/Motors	New	6 W Tr. Pump	MED	Effic.-ROF	Elect.	Elect.	\$9,741	-\$1,538	19	\$151	47.2	\$142	\$7,975	0.14
Pump/Motors	New	AHU Fan	ADM	CO2 Sensor	Elect.	Elect.	\$28,215	-\$87,292	1,221	\$7,643	0.0	\$0	\$3,886	0.14
Pump/Motors	New	3 Vac Pump	MED	Effic.-ROF	Elect.	Elect.	\$1,105	-\$126	2	\$15	4.1	\$12	\$143	0.13
Weather.	On	Heating	HGRH	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$174,000	\$0	2,475	\$10,963	NA	NA	\$22,330	0.13
Pump/Motors	New	5 Vac Pump	MED	Effic.-ROF	Elect.	Elect.	\$5,566	-\$868	11	\$84	24.9	\$75	\$691	0.12
Hot Water	On	Hot Water	HGRH	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$15,776	\$0	223	\$889	NA	NA	\$1,938	0.12
Pump/Motors	New	1 HW Pump	MED	Effic.-ROF	Elect.	Elect.	\$1,898	-\$185	3	\$24	5.6	\$17	\$215	0.11
Pump/Motors	New	4 Vac Pump	MED	Effic.-ROF	Elect.	Elect.	\$1,819	-\$278	3	\$27	7.1	\$21	\$194	0.11
Pump/Motors	New	13 Chill Pump	MED	Effic.-ROF	Elect.	Elect.	\$962	-\$103	2	\$15	2.0	\$6	\$102	0.11
Furn. & Bld.	Old	Heating	ADM	Boiler P New	Fuel Oil	Nat. Gas (d)	\$136,440	\$14,530	1,243	\$9,992	NA	NA	\$14,384	0.11
Hot Water	Old	Hot Water	MES	New DWH	Fuel Oil	Nat. Gas (d)	\$39,463	\$15,337	240	\$2,150	NA	NA	\$4,064	0.10
Weather.	Off	Heating	HGHN	Window Quilt	Propane	Propane	\$72,000	\$0	861	\$5,179	NA	NA	\$7,390	0.09
Pump/Motors	New	9 Cond Fan Ch	DGR	Effic.-ROF	Elect.	Elect.	\$3,798	-\$370	7	\$57	5.6	\$17	\$359	0.09
Weather.	On	Heating	HGSU	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$234,000	\$0	3,191	\$14,137	NA	NA	\$19,775	0.08
Weather.	On	Heating	HGYO	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$121,500	\$0	1,657	\$7,340	NA	NA	\$9,555	0.08
Weather.	On	Heating	MED	Effic.-ROF	Elect.	Elect.	\$803	-\$137	1	\$12	3.0	\$9	\$165	0.08
Weather.	Old	Heating	HGAD	Window Quilt	Fuel Oil	Fuel Oil	\$144,750	\$0	1,969	\$8,723	NA	NA	\$11,476	0.08
Hot Water	On	Hot Water	HGSU	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$21,216	\$0	288	\$1,276	NA	NA	\$1,627	0.08
Weather.	On	Heating	HGSU	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$11,016	\$0	149	\$662	NA	NA	\$845	0.08
Hot Water	On	Heating	HGSL	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$141,000	\$0	1,913	\$8,475	NA	NA	\$10,773	0.08
Weather.	On	Heating	HGAD	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$13,124	\$0	178	\$787	NA	NA	\$972	0.07
Hot Water	On	Hot Water	HGSL	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$12,784	\$0	173	\$765	NA	NA	\$910	0.07
Pump/Motors	Old	1 Chiller Cond	CLNIC	Effic.-ROF	Elect.	Elect.	\$518	-\$50	1	\$6	0.8	\$2	\$29	0.06
Pump/Motors	New	21 AC Comp.	MES	Effic.-ROF	Elect.	Elect.	\$2,416	-\$236	3	\$28	3.6	\$11	\$125	0.05
Pump/Motors	New	21 AC Comp.	CLB	Effic.-ROF	Elect.	Elect.	\$1,035	-\$101	1	\$11	1.5	\$5	\$52	0.05
Pump/Motors	New	11 Sec. Pump	ASS	Effic.-ROF	Elect.	Elect.	\$846	-\$109	1	\$5	3.1	\$9	\$30	0.04
Weather.	Old	Heating	REC	Window Quilt	Fuel Oil	Fuel Oil	\$7,902	\$0	97	\$481	NA	NA	\$214	0.03
Weather.	Old	Heating	ASS	Window Quilt	Fuel Oil	Fuel Oil	\$23,909	\$0	292	\$1,451	NA	NA	\$577	0.02
Weather.	Old	Heating	MTH	Floor Ins.	Fuel Oil	Fuel Oil	\$709	\$0	9	\$43	NA	NA	\$12	0.02
Furn. & Bld.	Old	Heating	COM	Convert B-New	Fuel Oil	Nat. Gas (d)	\$3,600	\$807	12	\$275	NA	NA	\$36	0.01
Furn. & Bld.	Old	Heating	ADM	Boiler P-Old	Fuel Oil	Nat. Gas (d)	\$90,960	\$9,687	822	\$5,658	NA	NA	\$879	0.01

Notes:

- (a) These fixtures are not considered for sensor retrofits.
 (b) These fixtures are considered for sensor retrofits.
 (c) The option is combined with an adjacent option to make a complete measure.
 (d) The value index has been calculated for the complete measure.
 (e) On-post natural gas rate.
 (f) Off-post natural gas rate.
 (g) This option has no installed cost. Therefore, no value index can be calculated.
 (h) For an explanation of the letters corresponding to the lighting EROs, see page B2.69.
 (i) This option has additional demand savings corresponding to a reduction in reactive demand
 These savings are included in the Net Present Value.

TABLE 3.6. Cumulative LCC Results - Winning EROs

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Cumulative Present Value of Installed Cost (1992 \$)	Cumulative Annual Energy Savings (MMBtu)	Cumulative Annual Demand (KW-mo)	Cumulative Value Of Annual Energy and Demand Savings (1992 \$)	Cumulative Net Present Value of ERO (1992 \$)
Trans. & Dist.	New	Heating	LOSS	Lower Temp.	Jones (HTHW)	Jones (HTHW)	\$0	39,000	0	\$167,505	\$2,824,128
Trans. & Dist.	Old/New	Trans. & Dist.	NA	CVR1-1	Elect.	Elect.	\$400	40,686	870	\$197,312	\$3,243,321
Trans. & Dist.	Old/New	Trans. & Dist.	NA	CVR2-1	Elect.	Elect.	\$800	41,529	1,306	\$212,209	\$3,452,621
Weather.	Old	Heating	BAM	Weatherstrip	Fuel Oil	Fuel Oil	\$978	41,683	1,306	\$212,971	\$3,465,298
Trans. & Dist.	New	Heating	LOSS	Line Deconias.	Jones (HTHW)	Jones (HTHW)	\$7,108	45,433	1,306	\$229,077	\$3,730,719
Weather.	Old	Heating	HAN	Weatherstrip	Fuel Oil	Fuel Oil	\$7,286	45,514	1,306	\$229,481	\$3,737,364
Pumps/Motors	New	Heating	SEWER	Downsize R	Elect.	Elect.	\$8,153	45,630	1,371	\$231,569	\$3,766,749
Trans. & Dist.	Old/New	Trans. & Dist.	HSP	PwrFCor a (h)	Elect.	Elect.	\$15,875	45,684	1,397	\$232,496	\$4,021,407
Weather.	Old	Heating	HSP	Weatherstrip	Fuel Oil	Fuel Oil	\$16,053	45,760	1,397	\$232,824	\$4,026,770
Streetlights	New	HPS Strds	NA	Weatherstrip	Elect.	Elect.	\$45,442	48,638	3,344	\$282,666	\$4,823,744
Lighting	Old/New	HPS 400 (Ext) (a)	B	Retro All	Fuel Oil	Fuel Oil	\$62,917	50,188	4,384	\$308,447	\$5,207,862
Weather.	Old	Heating	SIM	Weatherstrip	Fuel Oil	Fuel Oil	\$63,273	50,228	4,384	\$308,836	\$5,214,076
Pumps/Motors	New	7 HTHW Pump	CLD	Weatherstrip	Elect.	Elect.	\$65,844	50,393	4,376	\$311,229	\$5,244,455
Weather.	Old	Heating	DGR	Weatherstrip	Fuel Oil	Fuel Oil	\$74,108	51,396	4,364	\$316,213	\$5,321,972
Pumps/Motors	New	3 AHU Fan	SHF	Weatherstrip	Elect.	Elect.	\$74,965	51,563	4,360	\$317,751	\$5,341,651
Pumps/Motors	New	6 AHU Fan	GRO	2-SPD-RI	Elect.	Elect.	\$75,889	51,692	4,360	\$319,235	\$5,361,671
Controls	Old	Heating	OTH	FM System	Fuel Oil	Fuel Oil	\$76,505	51,780	4,360	\$319,670	\$5,369,180
Controls	Old	Heating	CLB	FM System	Fuel Oil	Fuel Oil	\$81,125	52,434	4,360	\$322,923	\$5,419,454
Trans. & Dist.	New	Heating	LOSS	Pipe Insulation	Jones (HTHW)	Jones (HTHW)	\$145,125	62,434	4,360	\$365,873	\$6,079,590
Lighting	Old/New	6x FL 2X4 3-34 STD (b)	D	Sensor	Elect.	Elect.	\$145,681	62,585	4,462	\$368,680	\$6,126,453
Controls	Old	Heating	MED	FM System	Fuel Oil	Fuel Oil	\$150,297	62,647	4,462	\$369,087	\$6,132,710
Weather.	Old	Heating	CLB	Weatherstrip	Fuel Oil	Fuel Oil	\$151,009	62,741	4,462	\$369,554	\$6,139,876
Pumps/Motors	New	5 AHU Fan	DGR	2-SPD-RI	Elect.	Elect.	\$151,757	62,779	4,459	\$370,095	\$6,146,508
Hot Water	Old	Hot Water	BAM	New DWH	Fuel Oil	Net. Gas (d)	\$153,834	62,821	4,459	\$372,170	\$6,164,436
Controls	Old	Heating	COM	FM System	Fuel Oil	Fuel Oil	\$154,450	62,891	4,459	\$372,517	\$6,169,675
Controls	Old	Heating	BAR	FM System	Fuel Oil	Fuel Oil	\$155,950	63,065	4,459	\$373,382	\$6,182,744
Furn. & Bks.	New	Heating	ASS	Add P.ck.	Jones (HTHW)	Net. Gas (d)	\$161,032	63,838	4,459	\$376,537	\$6,222,754
Pumps/Motors	New	5 AHU Fan	REC	2-SPD-RI	Elect.	Elect.	\$167,888	64,145	4,427	\$380,826	\$6,274,333
Lighting	Old/New	6x FL 2X4 3-34 STD (b)	A.B	Sensor	Elect.	Elect.	\$182,508	64,459	4,672	\$387,579	\$6,383,463
Pack-Shave	Old/New	Heating	NA	DGEN-8	Elect.	Diesel	\$378,508	34,657	35,872	\$577,851	\$7,746,336
Controls	Old	Heating	ASS	FM System	Fuel Oil	Fuel Oil	\$380,820	35,067	35,872	\$579,892	\$7,776,469
Controls	New	Heating	ADM	Night Set	Jones (HTHW)	Jones (HTHW)	\$415,418	38,974	35,872	\$596,673	\$8,023,791
Lighting	Old/New	HPS 100 Wall (Ext) (a)	B	Retro All	Elect.	Elect.	\$437,193	39,476	36,218	\$605,242	\$8,165,782
Hot Water	Old	Hot Water	SHF	New DWH	Fuel Oil	Net. Gas (d)	\$443,578	40,132	36,218	\$611,109	\$8,236,356
Pumps/Motors	New	4 AHU Fan	DGR	2-SPD-RI	Elect.	Elect.	\$448,216	40,159	36,213	\$611,472	\$8,240,610
Weather.	Old	Heating	HOT	Weatherstrip	Fuel Oil	Fuel Oil	\$448,394	40,174	36,213	\$611,550	\$8,243,673
Controls	Old	Heating	MES	FM System	Fuel Oil	Fuel Oil	\$448,702	40,201	36,213	\$611,882	\$8,243,673
Lighting	Old/New	Inc 60 Cell (a)	D	Retro All	Elect.	Elect.	\$492,262	40,898	36,651	\$624,954	\$8,476,188
Lighting	Old/New	Inc 2X60 Cell (a)	B	Retro All	Elect.	Elect.	\$511,019	41,354	36,998	\$633,158	\$8,624,403
Controls	Old	Heating	DGR	FM System	Fuel Oil	Fuel Oil	\$511,635	41,405	36,998	\$633,409	\$8,628,017
Controls	Old	Heating	ADM	FM System	Fuel Oil	Fuel Oil	\$523,647	42,358	36,998	\$638,147	\$8,695,955
Pumps/Motors	New	4 AHU Fan	REC	2-SPD-RI	Elect.	Elect.	\$620,632	42,568	36,974	\$641,078	\$8,729,372
Lighting	Old/New	FL 2X4 4-40 Std (a)	C	Retro All	Elect.	Elect.	\$620,805	44,552	38,219	\$678,865	\$9,234,254
Furn. & Bks.	Old	Heating	HSP	Boiler P. Old	Fuel Oil	Net. Gas (d)	\$635,859	45,007	38,219	\$686,046	\$9,337,512
Lighting	Old	Inc 4X40 (a)	E	Retro All	Elect.	Elect.	\$695,959	45,149	38,219	\$722,886	\$9,664,884
Lighting	Old/New	FL 2X4 6-40 Std (a)	B	Retro Sensor	Elect.	Elect.	\$735,726	46,973	39,218	\$759,681	\$9,841,243
Lighting	Old/New	FL 2X4 6-40 Std (b)	B	Retro Sensor	Elect.	Elect.	\$824,766	47,638	40,052	\$733,868	\$10,307,548
Lighting	Old/New	Exit 2X20 (a)	A	Retro All	Elect.	Elect.	\$1,045,886	49,320	40,727	\$762,142	\$11,486,508
Lighting	Old/New	Exit 2X20 (a)	D	Retro All	Elect.	Elect.	\$1,067,946	49,455	40,782	\$764,410	\$11,581,089
Pumps/Motors	Old	12 HTHW Pump	CLNIC	2-SPD-RI	Elect.	Elect.	\$1,069,443	49,503	40,777	\$765,084	\$11,588,616
Pumps/Motors	Old	6 AHU Fan	CLNIC	2-SPD-RI	Elect.	Elect.	\$1,071,157	49,559	40,769	\$765,951	\$11,597,219
Weather	Old	Heating	LAU	Weatherstrip	Fuel Oil	Fuel Oil	\$1,071,513	49,584	40,769	\$765,978	\$11,599,003

TABLE 3.6. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Cumulative Present Value of Installed Cost (1992 \$)	Cumulative Annual Energy Savings (MBtu)	Cumulative Annual Demand Savings (KW-mo)	Cumulative Value Of Annual Energy and Demand Savings (1992 \$)	Cumulative Net Present Value of ERO (1992 \$)
Pumps/Motors	New	2 AHU Fan	GRO	2-SPD-RI	Elect.	Elect.	\$1,072,281	49,608	40,766	\$766,310	\$11,802,890
Weather.	Old	Heating	REC	Weatherstrip	Fuel Oil	Fuel Oil	\$1,073,863	49,719	40,766	\$765,861	\$11,610,392
Pumps/Motors	New	1 Chilled Pump	DGR	2-SPD-RI	Elect.	Elect.	\$1,076,434	49,797	40,762	\$767,966	\$11,622,647
Lighting	Old/New	Ext 2X15 (a)	C	Retro All	Elect.	Elect.	\$1,083,574	49,835	40,777	\$768,606	\$11,656,433
Pumps/Motors	New	6 HTHW Pump	REC	2-SPD-RI	Elect.	Elect.	\$1,204,954	50,483	41,037	\$775,495	\$12,230,781
Lighting	Old/New	6 FL 2X4 3-34 STD (b)	A,B	Sensor	Elect.	Elect.	\$1,215,162	50,802	40,990	\$783,889	\$12,278,870
Pumps/Motors	New	5 AHU-1,2,3	BAR	2-SPD-RI	Elect.	Elect.	\$1,246,986	51,258	41,346	\$793,690	\$12,426,628
Pumps/Motors	New	6 AHU-4	BAR	2-SPD-RI	Elect.	Elect.	\$1,287,180	52,517	41,064	\$810,472	\$12,608,831
Pumps/Motors	New	11 MAHU	SMA	2-SPD-RI	Elect.	Elect.	\$1,300,578	52,936	40,970	\$816,065	\$12,669,269
Pumps/Motors	New	11 MAHU	SMA	2-SPD-RI	Elect.	Elect.	\$1,318,642	53,433	40,939	\$818,360	\$12,694,708
Controls	Old	Heating	WAR	FM System	Fuel Oil	Fuel Oil	\$1,321,722	53,433	40,872	\$823,410	\$12,750,870
Pumps/Motors	New	8 SMF Fan	SHP	2-SPD-RI	Elect.	Elect.	\$1,335,719	54,141	40,815	\$824,384	\$12,784,026
Pumps/Motors	New	8 SMF Fan	SMA	2-SPD-RI	Elect.	Elect.	\$1,347,432	54,360	40,790	\$831,533	\$12,841,587
Weather.	Old	Heating	DGR	Weatherstrip	Fuel Oil	Fuel Oil	\$1,349,034	54,461	40,790	\$834,597	\$12,874,824
Lighting	Old/New	5a FL 2X4 4-34 STD (b)	B	Retro & Sensor	Elect.	Elect.	\$1,393,370	55,095	41,218	\$845,108	\$13,070,096
Pumps/Motors	New	3 Return Fan	REC	2-SPD-RI	Elect.	Elect.	\$1,408,474	55,228	41,206	\$849,583	\$13,089,583
Pumps/Motors	New	10 MAHU	SMA	2-SPD-RI	Elect.	Elect.	\$1,437,039	56,169	41,153	\$854,003	\$13,131,909
Pumps/Motors	New	10 MAHU	SHP	2-SPD-RI	Elect.	Elect.	\$1,437,039	56,169	41,022	\$863,900	\$13,236,055
Pumps/Motors	New	8 Sup Wtr Pmp	BAR	2-SPD-RI	Elect.	Elect.	\$1,483,895	56,968	40,938	\$873,627	\$13,336,817
Lighting	Old/New	Inc 75 Can (a)	COM	Retro All	Elect.	Elect.	\$1,485,298	57,105	41,140	\$878,398	\$13,415,493
Hot Water	Old	Heating	HSP	Weatherstrip	Fuel Oil	Fuel Oil	\$1,486,366	57,165	41,140	\$878,693	\$13,419,407
Pumps/Motors	Old	Hot Water	HSP	New DWH	Fuel Oil	Elect.	\$1,488,443	57,240	41,140	\$879,367	\$13,426,975
Furn. & Bks.	New	9 AHU Fan	ASS	2-SPD-RI	Elect.	Elect.	\$1,492,959	57,356	41,115	\$880,922	\$13,443,360
Lighting	Old	Heating	ASS	Boiler P New	Fuel Oil	Elect.	\$1,515,699	58,276	41,115	\$888,313	\$13,523,853
Weather.	Old/New	5b FL 2X4 4-34 STD (b)	A	Retro & Sensor	Elect.	Elect.	\$1,595,279	60,665	41,543	\$899,394	\$13,679,688
Lighting	Old	Heating	BAR	Weatherstrip	Fuel Oil	Fuel Oil	\$1,606,888	60,799	41,668	\$908,640	\$13,800,439
Lighting	Old/New	FL 2X4 4-34 Std (b)	u	Retro&Sensor	Elect.	Elect.	\$1,606,888	60,799	41,668	\$911,381	\$13,833,854
Pumps/Motors	Old/New	FL 2X4 4-34 Std (a)	B	Retro&Sensor	Elect.	Elect.	\$2,225,188	69,144	48,755	\$1,079,071	\$15,952,392
Lighting	New	4 AHU-5,6	BAR	2-SPD-RI	Elect.	Elect.	\$2,251,954	69,731	48,567	\$1,088,116	\$16,043,564
Pumps/Motors	Off	Inc 3X40 (a)	E	Retro All	Elect.	Elect.	\$2,290,436	70,064	48,567	\$1,096,901	\$16,172,611
Pumps/Motors	Old	11 EXH Fan	CLNIC	2-SPD-RI	Elect.	Elect.	\$2,291,712	70,091	48,558	\$1,097,309	\$16,176,828
Furn. & Bks.	Old	Heating	SHP	Boiler P New	Fuel Oil	Elect.	\$2,399,832	73,964	48,558	\$1,128,442	\$16,506,464
Lighting	Old/New	INC 2X60 CEIL (b)	A	Retro & Sensor	Elect.	Elect.	\$2,423,560	75,970	48,577	\$1,136,592	\$16,511,381
Furn. & Bks.	New	Heating	REC	Add Pack.	Elect.	Elect.	\$2,423,560	75,970	48,577	\$1,136,592	\$16,586,018
Pumps/Motors	New	8 AHU Fan	ASS	2-SPD-RI	Elect.	Elect.	\$2,426,988	76,048	48,561	\$1,137,639	\$16,595,363
Lighting	Old/New	Inc 60 Cell (a)	B	Retro All	Elect.	Elect.	\$2,426,988	76,048	48,561	\$1,137,639	\$16,595,363
Pumps/Motors	Old	Heating	SHP	Furnace C-Old	Fuel Oil	Elect.	\$2,426,988	76,048	48,561	\$1,137,639	\$16,595,363
Pumps/Motors	New	7 Return Fan	ASS	2-SPD-RI	Elect.	Elect.	\$2,426,988	76,048	48,561	\$1,137,639	\$16,595,363
Lighting	Old/New	Inc 75 Cell (Ext) (a)	C	Retro All	Elect.	Elect.	\$2,426,988	76,048	48,561	\$1,137,639	\$16,595,363
Weather.	Old	Heating	ASS	Weatherstrip	Fuel Oil	Elect.	\$2,426,988	76,048	48,561	\$1,137,639	\$16,595,363
Lighting	Old/New	5d FL 2X4 4-34 STD (b)	B	Retro All	Elect.	Elect.	\$2,426,988	76,048	48,561	\$1,137,639	\$16,595,363
Lighting	Off	Inc 2X60 Cell (a)	E	Retro All	Elect.	Elect.	\$2,426,988	76,048	48,561	\$1,137,639	\$16,595,363
Weather.	Old	Heating	ASS	Weatherstrip	Fuel Oil	Elect.	\$2,426,988	76,048	48,561	\$1,137,639	\$16,595,363
Lighting	Old/New	FL 2X4 4-34 Std (b)	D	Retro&Sensor	Elect.	Elect.	\$2,426,988	76,048	48,561	\$1,137,639	\$16,595,363
Lighting	Old	Heating	OTH	Furnace C New	Fuel Oil	Elect.	\$2,426,988	76,048	48,561	\$1,137,639	\$16,595,363
Pumps/Motors	New	20 AHU Fan	MED	2-SPD-RI	Elect.	Elect.	\$3,013,381	82,523	49,236	\$1,257,278	\$18,206,402
Lighting	Old/New	7e FL 2X4 2-34 STD (b)	A,D	Sensor	Elect.	Elect.	\$3,013,381	82,523	49,236	\$1,257,278	\$18,206,402
Streetlights	Old	Merc Srtile	NA	Install HPS 200	Elect.	Elect.	\$3,013,381	82,523	49,236	\$1,257,278	\$18,206,402
Furn. & Bks.	Old	Heating	DGR	Furnace C-Old	Fuel Oil	Elect.	\$3,013,381	82,523	49,236	\$1,257,278	\$18,206,402
Lighting	Old/New	Inc 2X75 (a)	A	Retro All	Elect.	Elect.	\$3,013,381	82,523	49,236	\$1,257,278	\$18,206,402
Weather.	On	Heating	RAV	Window Quits	Elect.	Elect.	\$3,013,381	82,523	49,236	\$1,257,278	\$18,206,402
Pumps/Motors	Old	Heating	MES	Weatherstrip	Fuel Oil	Elect.	\$3,013,381	82,523	49,236	\$1,257,278	\$18,206,402
Lighting	Old	Heating	CLNIC	2-SPD-RI	Elect.	Elect.	\$3,013,381	82,523	49,236	\$1,257,278	\$18,206,402
Pumps/Motors	New	7 MP HHCBN	SMA	2-SPD RI	Elect.	Elect.	\$3,013,381	82,523	49,236	\$1,257,278	\$18,206,402

TABLE 3.6. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Cumulative Present Value of Installed Cost (1992 \$)	Cumulative Annual Energy Demand (MMBtu)	Cumulative Annual Energy Savings (1992 \$)	Cumulative Net Present Value of ERO (1992 \$)
Pumps/Motors	New	7 MP HHCEN	SHP	2-SPD-RI	Elect	Elect	\$3,665,059	88,764	\$1,382,146	\$19,824,882
Pumps/Motors	Old/New	10 SF-2	MED	2-SPD-RI	Elect	Elect	\$3,666,858	88,792	\$1,382,530	\$19,825,328
Lighting	Old/New	51 FL 2X4 4-34 STD (b)	B	Retro & Sensor	Elect	Elect	\$3,667,500	89,960	\$1,386,443	\$19,874,131
Pumps/Motors	New	FL 2X4 4-40 Std (a)	A	Retro All	Elect	Elect	\$3,688,388	89,959	\$1,386,621	\$19,876,012
Lighting	On	2 Return Fan	REC	2-SPD-RI	Elect	Elect	\$3,692,960	90,035	\$1,387,755	\$19,885,691
Pumps/Motors	New	FL 2X4 4-40 Std (a)	G	Retro All	Elect	Elect	\$3,702,745	90,139	\$1,389,720	\$19,906,448
Furn. & Bldg	Old	8 Booster EXH	MED	2-SPD-RI	Elect	Elect	\$3,707,887	90,223	\$1,390,957	\$19,917,267
Lighting	On	Heating	DGR	Furnace C New	Fuel Oil	Nat. Gas (d)	\$3,713,887	90,379	\$1,392,119	\$19,929,433
Weather.	Off	Inc 2X40 (a)	G	Retro All	Elect	Elect	\$3,805,223	91,049	\$1,405,316	\$20,119,737
Furn. & Bldg	Off	Heating	HGCR	Weather. Pack.	Nat. Gas (e)	Nat. Gas (e)	\$3,817,319	91,353	\$1,407,376	\$20,144,556
Lighting	Off	Heating	COM	Furnace C-Old	Fuel Oil	Elect	\$3,824,779	91,573	\$1,408,789	\$20,165,826
Lighting	Off	Inc 80 Cell (a)	E	Retro All	Elect	Elect	\$3,887,784	91,939	\$1,418,435	\$20,287,699
Pumps/Motors	Old/New	Inc 2X60 Cell (a)	A	Retro All	Elect	Elect	\$4,121,703	93,881	\$1,452,733	\$20,766,374
Lighting	New	11 AHU Fan	MED	2-SPD-RI	Elect	Elect	\$4,129,802	93,812	\$1,454,550	\$20,782,489
Lighting	On	Inc 2X60 Cell (a)	G	Retro All	Elect	Elect	\$4,764,907	98,535	\$1,547,503	\$22,071,209
Lighting	Old/New	5c FL 2X4 4-34 STD (b)	B	Retro & Sensor	Elect	Elect	\$5,273,547	102,216	\$1,637,731	\$23,092,336
Lighting	Off	Inc 100 Cell (a)	E	Retro All	Elect	Elect	\$5,446,183	103,382	\$1,668,756	\$23,433,963
Pumps/Motors	New	6 Exh Fans	SMA	2-SPD-RI	Elect	Elect	\$5,474,893	103,842	\$1,675,485	\$23,489,929
Furn. & Bldg.	Old	Heating	SHP	Boiler P-Old	Fuel Oil	Nat. Gas (d)	\$5,543,159	104,910	\$1,681,484	\$23,623,016
Lighting	New	8 Exh Fans	COM	Boiler P-Old	Fuel Oil	Nat. Gas (d)	\$5,550,739	105,124	\$1,692,955	\$23,637,689
Furn. & Bldg.	Old	Heating	CLB	Boiler P-Old	Fuel Oil	Nat. Gas (d)	\$5,556,899	105,500	\$1,696,074	\$23,666,088
Lighting	Old/New	5c FL 2X4 4-34 STD (b)	A,B	Retro & Sensor	Elect	Elect	\$5,578,023	105,555	\$1,697,459	\$23,681,399
Pumps/Motors	New	8 Supply Fan	REC	2-SPD-RI	Elect	Elect	\$5,579,874	105,651	\$1,698,512	\$23,685,929
Pumps/Motors	Old	1 Lift Pump Motor	SEWER	Effic. R/O	Elect	Elect	\$5,579,874	105,651	\$1,698,512	\$23,685,929
Lighting	Old/New	Ext 2xPL9 (a)	A	Retro All	Elect	Elect	\$5,649,874	105,964	\$1,704,020	\$23,692,261
Weather.	Off	Heating	ADM	Weatherstrip	Fuel Oil	Fuel Oil	\$5,689,212	107,282	\$1,710,568	\$23,891,546
Lighting	Off	FL 2X4 4-40 Std (a)	E	Retro All	Elect	Elect	\$5,719,944	107,495	\$1,716,184	\$23,948,826
Weather.	Off	Heating	HGWC	Weather. Pack.	Nat. Gas (e)	Nat. Gas (e)	\$5,731,056	107,755	\$1,717,952	\$23,966,780
Furn. & Bldg.	Old	Heating	OTH	Furnace C-Old	Fuel Oil	Nat. Gas (d)	\$5,729,116	107,948	\$1,719,193	\$23,979,481
Pumps/Motors	New	7 EXH Fan	REC	2-SPD-RI	Elect	Elect	\$5,752,238	108,134	\$1,722,027	\$24,001,273
Controls	Old	Heating	REC	FM System	Fuel Oil	Fuel Oil	\$5,753,470	108,172	\$1,722,219	\$24,003,279
Hot Water	Old	Hot Water	REC	New DWH	Fuel Oil	Nat. Gas (c)	\$5,759,701	108,291	\$1,723,283	\$24,013,421
Lighting	On	Inc 60 Wall (a)	G	Retro All	Elect	Elect	\$5,841,437	108,800	\$1,733,286	\$24,146,028
Pumps/Motors	Old/New	FL 2X4 4-34 Std (a)	A	Retro All	Elect	Elect	\$5,851,437	112,172	\$1,739,673	\$24,806,761
Pumps/Motors	New	9 MAHU	SHP	2-SPD-RI	Elect	Elect	\$5,851,437	112,172	\$1,739,673	\$24,806,761
Furn. & Bldg.	Old	Heating	MES	2-SPD-RI	Elect	Elect	\$5,851,437	112,172	\$1,739,673	\$24,806,761
Weather.	Off	Heating	HGAR	Furnace C-Old	Fuel Oil	Nat. Gas (f)	\$5,851,437	112,172	\$1,739,673	\$24,806,761
Lighting	On	Inc 150 Cell (a)	G	Retro All	Elect	Elect	\$5,851,437	112,172	\$1,739,673	\$24,806,761
Pumps/Motors	Old	Inc 150 Cell (a)	G	Retro All	Elect	Elect	\$5,851,437	112,172	\$1,739,673	\$24,806,761
Furn. & Bldg.	Old	Heating	CLB	Furnace C-Old	Fuel Oil	Nat. Gas (d)	\$5,851,437	112,172	\$1,739,673	\$24,806,761
Lighting	On	Inc 80 Cell (a)	G	Retro All	Elect	Elect	\$5,851,437	112,172	\$1,739,673	\$24,806,761
Lighting	Old/New	Inc 200 Sump (a)	B	Retro All	Elect	Elect	\$5,851,437	112,172	\$1,739,673	\$24,806,761
Furn. & Bldg.	Old	Heating	SHP	Furnace C New	Fuel Oil	Nat. Gas (d)	\$5,851,437	112,172	\$1,739,673	\$24,806,761
Weather.	Off	Heating	REC	Boiler P New	Fuel Oil	Nat. Gas (c)	\$5,851,437	112,172	\$1,739,673	\$24,806,761
Furn. & Bldg.	Off	Heating	HGEM	Weather. Pack	Nat. Gas (e)	Nat. Gas (e)	\$5,851,437	112,172	\$1,739,673	\$24,806,761
Lighting	Off	Heating	BAR	Furnace C-Old	Fuel Oil	Nat. Gas (d)	\$5,851,437	112,172	\$1,739,673	\$24,806,761
Furn. & Bldg.	Off	Heating	REC	Furnace C-Old	Fuel Oil	Nat. Gas (f)	\$5,851,437	112,172	\$1,739,673	\$24,806,761
Weather.	Off	Heating	HGCB	Weather. Pack	Nat. Gas (e)	Nat. Gas (e)	\$5,851,437	112,172	\$1,739,673	\$24,806,761
Weather.	Off	Heating	HGCA	Weather. Pack	Nat. Gas (e)	Nat. Gas (e)	\$5,851,437	112,172	\$1,739,673	\$24,806,761
Lighting	On	Heating	HGBO	Weather. Pack	Nat. Gas (e)	Nat. Gas (e)	\$5,851,437	112,172	\$1,739,673	\$24,806,761
Lighting	Old/New	Inc 100 Cell (a)	A	Retro All	Elect	Elect	\$5,851,437	112,172	\$1,739,673	\$24,806,761
Pumps/Motors	New	19 AHU Fan	MED	2-SPD-RI	Elect	Elect	\$5,851,437	112,172	\$1,739,673	\$24,806,761
Pumps/Motors	New	8 Dom Wtr Htr	DGR	Effic. RI	Elect	Elect	\$5,851,437	112,172	\$1,739,673	\$24,806,761
Furn. & Bldg.	Old	Heating	SHP	Boiler P Old	Fuel Oil	Nat. Gas (d)	\$5,851,437	112,172	\$1,739,673	\$24,806,761

TABLE 3.6. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Cumulative			Cumulative			Cumulative Present Value of ERO (1992 \$)
							Percent Installed Cost (1992 \$)	Cumulative Energy Savings (MMBtu)	Cumulative Annual Demand Savings (KW-mo)	Annual Energy Savings (1992 \$)	Value Of		
Lighting	Old/New	FL 2x4 2-34 Std (b)	A	Sensor	Elect.	Elect.	\$7,187,329	127,434	70,779	\$1,937,570	\$26,183,223		
	Old/New	FL 2x4 2-34 Std (a)	A	Sensor	Elect.	Elect.	\$7,187,329	127,434	70,779	\$1,937,570	\$26,183,223		
	Old/New	FL 1x4 2-34 Std (a)	A	Sensor	Elect.	Elect.	\$7,187,329	127,434	70,779	\$1,937,570	\$26,183,223		
	Old/New	FL 1x4 2-34 Std (b)	A	Sensor	Elect.	Elect.	\$7,187,329	127,434	70,779	\$1,937,570	\$26,183,223		
	Old/New	FL 1x4 2-34 Std (b)	A	Sensor	Elect.	Elect.	\$7,187,329	127,434	70,779	\$1,937,570	\$26,183,223		
	Old/New	FL 1x4 2-34 Std (b)	A	Sensor	Elect.	Elect.	\$7,187,329	127,434	70,779	\$1,937,570	\$26,183,223		
	Old/New	FL 1x4 2-34 Std (b)	A	Sensor	Elect.	Elect.	\$7,187,329	127,434	70,779	\$1,937,570	\$26,183,223		
	Old/New	FL 1x4 2-34 Std (b)	A	Sensor	Elect.	Elect.	\$7,187,329	127,434	70,779	\$1,937,570	\$26,183,223		
	Old/New	FL 1x4 2-34 Std (b)	A	Sensor	Elect.	Elect.	\$7,187,329	127,434	70,779	\$1,937,570	\$26,183,223		
	Old/New	FL 1x4 2-34 Std (b)	A	Sensor	Elect.	Elect.	\$7,187,329	127,434	70,779	\$1,937,570	\$26,183,223		
Furn. & Bldg.	Old/New	FL 1x4 2-34 Std (b)	MED	Furnace C-Old	Fuel Oil	Nat. Gas (d)	\$7,216,126	127,925	70,826	\$1,941,361	\$26,198,682		
	Old/New	FL 1x4 2-34 Std (b)	HGAC	Weather. Pack.	Nat. Gas (e)	Nat. Gas (e)	\$7,226,648	128,139	70,826	\$1,942,812	\$26,213,097		
	Old/New	FL 1x4 2-34 Std (b)	HGLE	Window Quilt	Fuel Oil	Fuel Oil	\$7,237,896	128,441	70,826	\$1,944,314	\$26,227,175		
	Old/New	FL 1x4 2-34 Std (b)	HGCA	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$7,252,296	128,849	70,826	\$1,946,118	\$26,248,084		
	Old/New	FL 1x4 2-34 Std (b)	ADM	CO2 Sensor	Elect.	Elect.	\$7,280,511	130,375	70,826	\$1,955,673	\$26,278,873		
	Old/New	FL 1x4 2-34 Std (b)	E	Retro All	Elect.	Elect.	\$7,349,710	130,671	70,826	\$1,963,459	\$26,301,597		
	Old/New	FL 1x4 2-34 Std (b)	E	Retro All	Elect.	Elect.	\$7,411,971	130,938	70,826	\$1,970,540	\$26,326,061		
	Old/New	FL 1x4 2-34 Std (b)	HGCB	Weather. Pack.	Nat. Gas (e)	Nat. Gas (e)	\$7,428,371	131,188	70,826	\$1,972,298	\$26,348,149		
	Old/New	FL 1x4 2-34 Std (b)	C	Retro All	Elect.	Elect.	\$7,489,363	132,651	71,111	\$1,980,945	\$26,372,347		
	Old/New	FL 1x4 2-34 Std (b)	C	Retro All	Elect.	Elect.	\$7,586,928	132,609	71,547	\$1,995,361	\$26,400,278		
Furn. & Bldg.	Old/New	FL 1x4 1-40 Std (a)	HGSA	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$7,596,528	132,609	71,547	\$1,996,429	\$26,660,999		
	Old/New	FL 1x4 1-40 Std (a)	LAU	Boiler P-Old	Fuel Oil	Nat. Gas (d)	\$7,603,108	132,764	71,544	\$1,996,655	\$26,682,459		
	Old/New	FL 1x4 1-40 Std (a)	MED	2-SPD-RI	Elect.	Elect.	\$7,604,384	132,781	71,544	\$1,996,655	\$26,682,459		
	Old/New	FL 1x4 1-40 Std (a)	MED	2-SPD-RI	Fuel Oil	Nat. Gas (d)	\$7,628,384	137,241	71,544	\$2,025,356	\$26,917,481		
	Old/New	FL 1x4 1-40 Std (a)	ADM	Furnace C-Old	Fuel Oil	Nat. Gas (d)	\$7,656,984	137,952	71,638	\$2,039,682	\$26,949,774		
	Old/New	FL 1x4 1-40 Std (a)	RAV	Ceiling Insulation-40	Elect.	Elect.	\$7,674,456	137,962	71,638	\$2,031,718	\$26,968,769		
	Old/New	FL 1x4 1-40 Std (a)	HGCL	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$7,896,384	138,499	71,638	\$2,034,143	\$26,991,270		
	Old/New	FL 1x4 1-40 Std (a)	HGJ	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$7,897,461	138,529	71,638	\$2,034,408	\$26,993,478		
	Old/New	FL 1x4 1-40 Std (a)	HOT	New DWH	Fuel Oil	Nat. Gas (d)	\$7,901,891	138,614	71,638	\$2,034,958	\$26,998,085		
	Old/New	FL 1x4 1-40 Std (a)	LAU	Furnace C-Old	Fuel Oil	Nat. Gas (d)	\$7,914,424	139,114	71,638	\$2,037,337	\$27,011,015		
Furn. & Bldg.	Old/New	FL 1x4 1-40 Std (a)	SHF	Floor Ins.	Nat. Gas (d)	Nat. Gas (d)	\$7,922,104	139,114	71,638	\$2,037,337	\$27,011,015		
	Old/New	FL 1x4 1-40 Std (a)	HGWI	Weather. Pack.	Fuel Oil	Nat. Gas (d)	\$7,932,578	139,126	71,638	\$2,038,627	\$27,019,370		
	Old/New	FL 1x4 1-40 Std (a)	OTH	Floor Ins.	Propane	Propane	\$7,932,178	139,331	71,638	\$2,038,627	\$27,019,370		
	Old/New	FL 1x4 1-40 Std (a)	HGCL	Weather. Pack.	Propane	Propane	\$7,934,255	139,359	71,638	\$2,038,627	\$27,019,370		
	Old/New	FL 1x4 1-40 Std (a)	SIM	New DWH	Fuel Oil	Nat. Gas (d)	\$7,934,769	139,371	71,638	\$2,038,938	\$27,031,206		
	Old/New	FL 1x4 1-40 Std (a)	SIM	New DWH	Fuel Oil	Nat. Gas (d)	\$7,934,769	139,371	71,638	\$2,038,938	\$27,031,206		
	Old/New	FL 1x4 1-40 Std (a)	SIM	New DWH	Fuel Oil	Nat. Gas (d)	\$7,934,769	139,371	71,638	\$2,038,938	\$27,031,206		
	Old/New	FL 1x4 1-40 Std (a)	SIM	New DWH	Fuel Oil	Nat. Gas (d)	\$7,934,769	139,371	71,638	\$2,038,938	\$27,031,206		
	Old/New	FL 1x4 1-40 Std (a)	SIM	New DWH	Fuel Oil	Nat. Gas (d)	\$7,934,769	139,371	71,638	\$2,038,938	\$27,031,206		
	Old/New	FL 1x4 1-40 Std (a)	SIM	New DWH	Fuel Oil	Nat. Gas (d)	\$7,934,769	139,371	71,638	\$2,038,938	\$27,031,206		
Pumps/Motors	Old/New	FL 1x4 1-40 Std (a)	MED	2-SPD-RI	Elect.	Elect.	\$7,936,683	139,396	71,629	\$2,040,040	\$27,033,047		
	Old/New	FL 1x4 1-40 Std (a)	HGPA	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$7,943,883	139,574	71,629	\$2,040,040	\$27,033,047		
	Old/New	FL 1x4 1-40 Std (a)	HGRE	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$7,961,931	140,019	71,629	\$2,042,010	\$27,057,197		
	Old/New	FL 1x4 1-40 Std (a)	HGLO	Weather. Pack.	Propane	Propane	\$7,961,931	140,019	71,629	\$2,042,010	\$27,057,197		
	Old/New	FL 1x4 1-40 Std (a)	HGEB	Weather. Pack.	Propane	Propane	\$7,967,307	140,132	71,629	\$2,042,695	\$27,082,318		
	Old/New	FL 1x4 1-40 Std (a)	HGEB	Weather. Pack.	Propane	Propane	\$7,967,307	140,132	71,629	\$2,042,695	\$27,082,318		
	Old/New	FL 1x4 1-40 Std (a)	HGEB	Weather. Pack.	Propane	Propane	\$7,967,307	140,132	71,629	\$2,042,695	\$27,082,318		
	Old/New	FL 1x4 1-40 Std (a)	HGEB	Weather. Pack.	Propane	Propane	\$7,967,307	140,132	71,629	\$2,042,695	\$27,082,318		
	Old/New	FL 1x4 1-40 Std (a)	HGEB	Weather. Pack.	Propane	Propane	\$7,967,307	140,132	71,629	\$2,042,695	\$27,082,318		
	Old/New	FL 1x4 1-40 Std (a)	HGEB	Weather. Pack.	Propane	Propane	\$7,967,307	140,132	71,629	\$2,042,695	\$27,082,318		
Furn. & Bldg.	Old/New	FL 1x4 1-40 Std (a)	BAR	2-SPD-RI	Elect.	Elect.	\$8,007,130	140,666	71,594	\$2,048,375	\$27,099,793		
	Old/New	FL 1x4 1-40 Std (a)	HGCA	Fuse Damper	Nat. Gas (e)	Nat. Gas (e)	\$8,017,330	140,828	71,594	\$2,049,477	\$27,109,331		
	Old/New	FL 1x4 1-40 Std (a)	HGCR	Fuse Damper	Nat. Gas (e)	Nat. Gas (e)	\$8,026,998	140,965	71,594	\$2,050,402	\$27,117,332		
	Old/New	FL 1x4 1-40 Std (a)	HGCR	Fuse Damper	Nat. Gas (e)	Nat. Gas (e)	\$8,043,306	141,240	71,594	\$2,052,270	\$27,133,379		
	Old/New	FL 1x4 1-40 Std (a)	HGAR	Fuse Damper	Nat. Gas (e)	Nat. Gas (e)	\$8,044,553	141,289	71,594	\$2,052,412	\$27,134,520		
	Old/New	FL 1x4 1-40 Std (a)	CLB	Floor Ins.	Propane	Propane	\$8,051,753	141,418	71,594	\$2,053,309	\$27,141,082		
	Old/New	FL 1x4 1-40 Std (a)	HGCG	Weather. Pack.	Fuel Oil	Fuel Oil	\$8,052,959	141,448	71,594	\$2,053,450	\$27,142,214		
	Old/New	FL 1x4 1-40 Std (a)	MTH	Weatherstrip	Fuel Oil	Fuel Oil	\$8,075,271	141,977	71,594	\$2,055,759	\$27,162,013		
	Old/New	FL 1x4 1-40 Std (a)	HGRH	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$8,075,271	141,977	71,594	\$2,055,759	\$27,162,013		
	Old/New	FL 1x4 1-40 Std (a)	HGEM	Fuse Damper	Nat. Gas (e)	Nat. Gas (e)	\$8,095,671	142,294	71,594	\$2,057,949	\$27,180,111		
Furn. & Bldg.	Old/New	FL 1x4 3-34 Std (b)	D	RetroSensor	Elect.	Elect.	\$8,193,860	142,870	71,560	\$2,068,648	\$27,268,787		
	Old/New	FL 1x4 3-34 Std (b)	D	RetroSensor	Elect.	Elect.	\$8,200,870	143,020	72,054	\$2,071,428	\$27,287,560		
	Old/New	FL 1x4 3-34 Std (b)	WAR	Weatherstrip	Fuel Oil	Fuel Oil	\$8,238,831	143,422	72,054	\$2,073,427	\$27,303,132		
	Old/New	FL 1x4 3-34 Std (b)	HGWC	Fuse Damper	Nat. Gas (e)	Nat. Gas (e)	\$8,247,127	143,549	72,054	\$2,074,288	\$27,310,246		
	Old/New	FL 1x4 3-34 Std (b)	HGWC	Fuse Damper	Nat. Gas (e)	Nat. Gas (e)	\$8,247,127	143,549	72,054	\$2,074,288	\$27,310,246		
	Old/New	FL 1x4 3-34 Std (b)	HGWC	Fuse Damper	Nat. Gas (e)	Nat. Gas (e)	\$8,247,127	143,549	72,054	\$2,074,288	\$27,310,246		
	Old/New	FL 1x4 3-34 Std (b)	HGWC	Fuse Damper	Nat. Gas (e)	Nat. Gas (e)	\$8,247,127	143,549	72,054	\$2,074,288	\$27,310,246		
	Old/New	FL 1x4 3-34 Std (b)	HGWC	Fuse Damper	Nat. Gas (e)	Nat. Gas (e)	\$8,247,127	143,549	72,054	\$2,074,288	\$27,310,246		
	Old/New	FL 1x4 3-34 Std (b)	HGWC	Fuse Damper	Nat. Gas (e)	Nat. Gas (e)	\$8,247,127	143,549	72,054	\$2,074,288	\$27,310,246		
	Old/New	FL 1x4 3-34 Std (b)	HGWC	Fuse Damper	Nat. Gas (e)	Nat. Gas (e)	\$8,247,127	143,549	72,054	\$2,074,288	\$27,310,246		
Furn. & Bldg.	Old/New	FL 1x4 3-34 Std (b)	ASS	New DWH	Fuel Oil	Nat. Gas (d)	\$8,265,826	143,782	72,054	\$2,076,371	\$27,326,134		
	Old/New	FL 1x4 3-34 Std (b)	HGWN	Weather. Pack.	Propane	Propane	\$8,275,036	143,967	72,054	\$2,077,481	\$27,333,931		
	Old/New	FL 1x4 3-34 Std (b)	HGWN	Weather. Pack.	Propane	Propane	\$8,275,036	143,967	72,054	\$2,077,481	\$27,333,931		
	Old/New	FL 1x4 3-34 Std (b)	HGWN	Weather. Pack.	Propane	Propane	\$8,275,036	143,967	72,054	\$2,077,481	\$27,333,931		
	Old/New	FL 1x4 3-34 Std (b)	HGWN	Weather. Pack.	Propane	Propane	\$8,275,036	143,967	72,054	\$2,077,481	\$27,333,931		
	Old/New	FL 1x4 3-34 Std (b)	HGWN	Weather. Pack.	Propane	Propane	\$8,275,036	143,967	72,054	\$2,077,481	\$27,333,931		
	Old/New	FL 1x4 3-34 Std (b)	HGWN	Weather. Pack.	Propane	Propane	\$8,275,036	143,967	72,054	\$2,077,481	\$27,333,931		
	Old/New	FL 1x4 3-34 Std (b)	HGWN	Weather. Pack.	Propane	Propane	\$8,275,036	143,967	72,054	\$2,077,481	\$27,333,931		
	Old/New	FL 1x4 3-34 Std (b)	HGWN	Weather. Pack.	Propane	Propane	\$8,275,036	143,967	72,054	\$2,077,481	\$27,333,931		
	Old/New	FL 1x4 3-34 Std (b)	HGWN	Weather. Pack.	Propane	Propane	\$8,275,036	143,967	72,054	\$2,077,481	\$27,333,931		
Furn. & Bldg.	Old/New	FL 1x4 3-34 Std (b)	DGR	Window Quilt	Fuel Oil	Nat. Gas (d)	\$8,292,334	144,014	72,054	\$2,077,714	\$27,345,734		
	Old/New	FL 1x4 3-34 Std (b)	SIM	Boiler P New	Fuel Oil	Nat. Gas (d)	\$8,292,334	144,014	72,054	\$2,077,714	\$27,345,734		
	Old/New	FL 1x4 3-34 Std (b)	HGCR	Window Quilt	Fuel Oil	Nat. Gas (d)	\$8,292,334	144,014	72,054	\$2,077,714	\$27,345,734		
	Old/New	FL 1x4 3-34 Std (b)	HGCR	Window Quilt	Fuel Oil	Nat. Gas (d)	\$8,292,334	144,014	72,054	\$2,077,714	\$27,345,734		
	Old/New	FL 1x4 3-34 Std (b)	HGCR	Window Quilt	Fuel Oil	Nat. Gas (d)	\$8,292,334	144,014	72,054	\$2,077,714	\$27,345,734		
	Old/New	FL 1x4 3-34 Std (b)	HGCR	Window Quilt	Fuel Oil	Nat. Gas (d)	\$8,292,334	144,014	72,054	\$2,077,714	\$27,345,734		
	Old/New	FL 1x4 3-34 Std (b)	HGCR	Window Quilt	Fuel Oil	Nat. Gas (d)	\$8,292,334	144,014	72,054	\$2,077,714	\$27,345,734		
	Old/New	FL 1x4 3-34 Std (b)	HGCR	Window Quilt	Fuel Oil	Nat. Gas (d)	\$8,292,334	144,014	72,054	\$2,077,714	\$27,345,734		
	Old/New	FL 1x4 3-34 Std (b)	HGCR	Window Quilt	Fuel Oil	Nat. Gas (d)	\$8,292,334	144,014	72,054	\$2,077,714	\$27,345,734		
	Old/New	FL 1x4 3-34 Std (b)	HGCR	Window Quilt	Fuel Oil	Nat. Gas (d)	\$8,292,334	144,014	72,054	\$2,077,714	\$27,345,734		
Furn. & Bldg.	Old/New	FL 1x4 3-34 Std (b)	A.D	Sensor	Elect.	Elect.	\$8,386,834	145,671	72,059	\$2,085,253	\$27,428,144		
	Old/New	FL 1x4 3-34 Std (b)	HGSU	Weather. Pack	Nat. Gas (d)	Nat. Gas (d)	\$8,386,834	145,671	72,059	\$2,085,253	\$27,428,144		
	Old/New	FL 1x4 3-34 Std (b)	HGSU	Weather. Pack	Nat. Gas (d)	Nat. Gas (d)	\$8,386,834	145,671	72,059	\$2,085,253	\$27,428,144		
	Old/New	FL 1x4 3-34 Std (b)	HGSU	Weather. Pack	Nat. Gas (d)	Nat. Gas (d)	\$8,386,834	145,671	72,059	\$2,085,253	\$27,428,144		
	Old/New	FL 1x4 3-34 Std (b)	HGSU	Weather. Pack	Nat. Gas (d)	Nat. Gas (d)	\$8,386,834	145,671	72,059	\$2,085,253	\$27,428,144		
	Old/New	FL 1x4 3-34 Std (b)	HGSU	Weather. Pack	Nat. Gas (d)	Nat. Gas (d)	\$8,386,834	145,671	72,059	\$2,085,253	\$27,428,144		

TABLE 3.6. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Cumulative Present Value of Installed Cost (1992 \$)	Cumulative Annual Energy Savings (MMBtu)	Cumulative Annual Demand Savings (KW-mo)	Cumulative Value Of Annual Demand and Demand (1992 \$)	Cumulative Net Present Value of ERO (1992 \$)
Weather Pump/Motors	On	Heating	HGSL	Weather. Pack.	Nat. Gas (d)	Nat. Gas (d)	\$8,470,548	147,549	72,059	\$2,097,697	\$27,493,824
Lighting	Old/New	2 Chill Supply	CLNIC	2-SPD-RI	Elect.	Elect.	\$8,471,822	147,549	72,059	\$2,097,892	\$27,494,845
Furn. & Bld.	Off	FL 1X8 2-96 Std (e)	B	Retro All	Elect.	Elect.	\$8,529,282	147,862	72,311	\$2,103,913	\$27,540,327
Pump/Motors	New	5 SMF Fans	HGCB	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$8,539,492	148,012	72,311	\$2,104,931	\$27,548,362
Pump/Motors	New	5 SMF Fans	SHF	2-SPD-RI	Elect.	Elect.	\$8,561,473	148,161	72,253	\$2,106,770	\$27,557,722
Furn. & Bld.	Old	Heating	SMA	Boiler P New	Fuel Oil	Elect.	\$8,596,608	148,224	72,228	\$2,107,958	\$27,561,731
Lighting	Old/New	Inc 100 Susp (a)	CLD	Boiler P New	Elect.	Elect.	\$8,573,277	148,468	72,238	\$2,109,415	\$27,573,528
Furn. & Bld.	Old/New	7b FL 2X4 2-34 STD (b)	B	Sensor	Elect.	Elect.	\$8,602,507	148,611	72,313	\$2,112,318	\$27,597,276
Weather Pump/Motors	Old	Heating	MED	Furnace C New	Fuel Oil	Nat. Gas (d)	\$8,628,307	149,000	72,313	\$2,115,211	\$27,617,007
Furn. & Bld.	Old	Heating	BAR	Boiler P New	Fuel Oil	Nat. Gas (d)	\$8,656,527	150,027	72,313	\$2,123,469	\$27,668,689
Weather Pump/Motors	Old	Heating	OTH	Weatherstrip	Fuel Oil	Fuel Oil	\$8,698,307	150,085	72,313	\$2,123,654	\$27,670,035
Lighting	Old/New	7 Lift Pump Motor	SEWER	2-SPD-RI	Elect.	Elect.	\$8,699,008	150,072	72,314	\$2,123,757	\$27,670,565
Lighting	Old/New	FL 1X4 2-34 Std WP (a)	D	Retro/Sensor	Elect.	Elect.	\$8,743,416	150,303	72,458	\$2,128,038	\$27,700,469
Furn. & Bld.	Off	FL 1X4 2-34 Std WP (b)	D	Retro/Sensor	Elect.	Elect.	\$8,892,360	151,111	72,970	\$2,143,029	\$27,815,910
Lighting	Old/New	8d FL 2X4 3-34 STD (b)	HGAC	Flue Damper	Nat. Gas (e)	Nat. Gas (e)	\$8,905,872	151,228	72,970	\$2,143,827	\$27,822,032
Furn. & Bld.	Old	Heating	D	Retro & Sensor	Elect.	Elect.	\$8,951,352	151,253	72,992	\$2,144,342	\$27,825,985
Weather Pump/Motors	Old	Heating	BAR	Boiler P Old	Fuel Oil	Nat. Gas (d)	\$8,965,525	152,284	72,992	\$2,145,446	\$27,859,426
Furn. & Bld.	Old	Heating	MES	Window Quilt	Fuel Oil	Fuel Oil	\$8,963,425	161,946	72,992	\$2,222,744	\$28,343,025
Weather Pump/Motors	Old	Heating	ASS	Furnace C New	Fuel Oil	Nat. Gas (d)	\$9,681,435	162,651	72,982	\$2,227,983	\$28,377,582
Lighting	Old/New	Inc 75 Perm Pump	ASS	Furnace C New	Elect.	Elect.	\$9,683,977	162,685	72,986	\$2,228,355	\$28,379,386
Hot Water	Old/New	Inc 10 Vap Pump	A	Retro All	Elect.	Elect.	\$9,840,944	163,393	73,596	\$2,242,290	\$28,489,074
Pump/Motors	Old	Hot Water	CLNIC	Effic.-ROF	Elect.	Nat. Gas (d)	\$10,218,918	167,581	73,596	\$2,279,728	\$28,748,806
Hot Water	Old	Hot Water	ASS	Furnace C-Old	Fuel Oil	Nat. Gas (d)	\$10,237,541	167,588	73,598	\$2,279,775	\$28,749,196
Pump/Motors	On	Hot Water	HGLE	New DWH	Fuel Oil	Nat. Gas (d)	\$10,247,756	167,876	73,598	\$2,281,478	\$28,761,442
Weather Pump/Motors	Off	Heating	GRO	Effic.-ROF	Elect.	Elect.	\$10,255,031	167,935	73,636	\$2,282,491	\$28,772,661
Lighting	Old/New	FL 5X4 2-40 Std (a)	HGWC	Weather. Pack.	Propane	Propane	\$10,262,231	168,062	73,636	\$2,283,256	\$28,777,179
Furn. & Bld.	Old/New	FL 1X4 2-40 Std (a)	B	Window Quilt	Nat. Gas (e)	Nat. Gas (e)	\$10,353,731	169,279	73,636	\$2,291,507	\$28,833,455
Lighting	Old/New	FL 1X4 2-40 Std (a)	B	Retro All	Elect.	Elect.	\$10,379,411	169,399	73,738	\$2,293,919	\$28,847,941
Furn. & Bld.	Off	Heating	HGLE	Furn-C	Elect.	Elect.	\$10,619,651	170,522	74,691	\$2,316,479	\$28,963,458
Weather Pump/Motors	New	3 Chiller	HGAR	Window Quilt	Fuel Oil	Nat. Gas (e)	\$10,648,151	170,802	74,691	\$2,318,888	\$28,999,114
Lighting	Old/New	Inc 150 Susp (a)	DGR	Effic.-ROF	Elect.	Elect.	\$10,843,305	173,270	74,705	\$2,335,463	\$29,103,937
Furn. & Bld.	Off	Heating	DGR	Effic.-ROF	Elect.	Elect.	\$10,845,927	173,288	74,717	\$2,335,686	\$29,105,655
Lighting	Old/New	FL 1X4 2-34 Std (a)	C	Retro All	Elect.	Elect.	\$10,865,817	173,401	74,788	\$2,338,021	\$29,117,572
Pump/Motors	Old/New	Inc 150 Susp (a)	SEWER	2-SPD-RI	Elect.	Elect.	\$10,866,518	173,408	74,789	\$2,338,113	\$29,117,937
Hot Water	New	1 HW Pump	SHF	Retro All	Elect.	Elect.	\$10,988,489	174,364	75,601	\$2,357,328	\$29,181,547
Lighting	Old/New	FL 1X4 2-34 Std (a)	B	Effic.-ROF	Elect.	Elect.	\$11,001,570	174,445	75,657	\$2,358,143	\$29,188,162
Pump/Motors	New	1 HW Pump	SMA	Effic.-ROF	Elect.	Elect.	\$11,007,149	174,480	75,681	\$2,358,490	\$29,190,980
Hot Water	Off	Hot Water	HGCL	Flue Damper	Propane	Propane	\$11,013,949	174,589	75,681	\$2,358,149	\$29,194,275
Lighting	Off	FL 5X4 2-40 Std (a)	E	Retro All	Elect.	Elect.	\$11,105,194	174,900	75,681	\$2,367,354	\$29,237,942
Hot Water	Off	Hot Water	HGLO	Flue Damper	Propane	Propane	\$11,109,002	174,961	75,681	\$2,367,719	\$29,239,731
Pump/Motors	Old	Heating	HOT	Boiler P New	Fuel Oil	Nat. Gas (d)	\$11,116,582	175,055	75,681	\$2,368,474	\$29,243,253
Lighting	Old/New	FL 1X4 2-34 Std (a)	B	Effic.-ROF	Elect.	Elect.	\$11,117,117	175,058	75,683	\$2,368,509	\$29,243,501
Weather Pump/Motors	Old/New	FL 1X4 2-34 Std (b)	B	Retro/Sensor	Elect.	Elect.	\$11,166,131	175,225	75,824	\$2,371,848	\$29,265,139
Furn. & Bld.	Old	Heating	COM	Floor Ins.	Elect.	Elect.	\$11,179,933	175,276	75,880	\$2,372,935	\$29,272,561
Lighting	Old/New	FL 1X4 2-34 Std (a)	MES	Window Quilt	Fuel Oil	Fuel Oil	\$11,180,959	175,294	75,880	\$2,373,028	\$29,273,034
Weather Pump/Motors	Old	Heating	HGEM	Furnace C New	Fuel Oil	Nat. Gas (d)	\$11,282,689	175,283	75,880	\$2,380,383	\$29,310,101
Lighting	Old/New	FL 2X4 3-40 Std (a)	A	Window Quilt	Elect.	Elect.	\$11,487,669	178,976	75,880	\$2,398,640	\$29,412,064
Hot Water	Off	Hot Water	HGWC	Sensor	Elect.	Elect.	\$11,488,453	178,975	75,884	\$2,398,708	\$29,412,412
Furn. & Bld.	Old/New	FL 2X4 3-40 Std (b)	A	Flue Damper	Propane	Propane	\$11,453,553	179,058	75,884	\$2,395,187	\$29,414,652
Lighting	Old/New	FL 2X4 3-40 Std (a)	WAR	Furnace C-Old	Elect.	Elect.	\$11,615,683	180,620	75,884	\$2,405,237	\$29,467,787
Lighting	Old/New	FL 2X4 2-34 Std (a)	D	Retro All	Elect.	Elect.	\$11,624,755	180,654	75,905	\$2,405,865	\$29,471,596

TABLE 3.6. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Cumulative Present Value of Installed Cost (1992 \$)	Cumulative Annual Energy Savings (MMBtu)	Cumulative Annual Demand Savings (KW-mo)	Cumulative Value of Annual Demand Savings (1992 \$)	Cumulative Net Present Value of ERO (1992 \$)
Hot Water Weather.	Old	Hot Water Heating	MED	New DWH Window Quilt	Fuel Oil	Nat. Gas (d)	\$11,647,602	180,856	75,905	\$2,411,668	\$29,481,360
Weather.	Off	Heating	HGB	Window Quilt	Nat. Gas (e)	Nat. Gas (e)	\$11,815,602	182,817	75,905	\$2,424,966	\$29,551,510
Weather.	Off	Heating	HGCA	Window Quilt	Nat. Gas (e)	Nat. Gas (e)	\$11,928,102	184,127	75,905	\$2,433,847	\$29,598,058
Weather.	Old	Heating	ADM	Floor Ins.	Fuel Oil	Fuel Oil	\$11,951,909	184,526	75,905	\$2,435,831	\$29,607,732
Weather.	Old	Heating	ASS	Floor Ins.	Fuel Oil	Fuel Oil	\$11,956,148	184,597	75,905	\$2,436,184	\$29,609,455
Weather.	Old	Heating	MED	Floor Ins.	Fuel Oil	Fuel Oil	\$11,958,263	184,633	75,905	\$2,436,360	\$29,610,314
Weather.	On	Heating	HGBO	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$12,025,013	185,814	75,905	\$2,441,591	\$29,637,234
Lighting	Old/New	FL 1X4 1-40 Std (e)	B	Retro All	Elect.	Elect.	\$12,025,957	185,817	75,908	\$2,441,862	\$29,637,610
Hot Water	On	Hot Water	HGBO	Retro Dampers	Nat. Gas (d)	Nat. Gas (d)	\$12,032,009	185,924	75,908	\$2,442,134	\$29,640,010
Lighting	Off	Hot Water	HGBO	Flue Damper	Propane	Propane	\$12,038,537	186,022	75,908	\$2,442,726	\$29,642,555
Pumps/Motors	Old/New	FL 5X4 1-34 Std (e)	B	Retro All	Elect.	Elect.	\$12,041,937	186,034	75,918	\$2,442,971	\$29,643,815
Weather.	New	2 AHU Fan	ADM	Effic.-ROF	Elect.	Elect.	\$12,052,337	186,074	75,977	\$2,443,466	\$29,647,833
Pumps/Motors	Old	Heating	REC	Floor Ins.	Fuel Oil	Fuel Oil	\$12,054,417	186,108	75,977	\$2,443,633	\$29,648,373
Pumps/Motors	New	4 Exh Fans	SHP	2-SPD-ROF	Elect.	Elect.	\$12,076,261	186,373	75,869	\$2,445,794	\$29,656,093
Pumps/Motors	New	16 Supply Pmp	SMA	2-SPD-ROF	Elect.	Elect.	\$12,085,477	186,484	75,823	\$2,446,705	\$29,659,346
Weather.	Off	Heating	HGAC	Window Quilt	Nat. Gas (e)	Nat. Gas (e)	\$12,086,029	186,486	75,828	\$2,446,732	\$29,659,542
Lighting	Old/New	FL 2X4 3-34 Std (b)	B	Retro/Sensor	Elect.	Elect.	\$12,176,029	187,485	75,128	\$2,453,504	\$29,690,834
Weather.	Old/New	FL 2X4 3-34 Std (a)	B	Retro/Sensor	Elect.	Elect.	\$13,088,491	190,944	79,128	\$2,524,402	\$30,030,956
Weather.	On	Heating	HGCA	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$13,352,951	191,868	79,914	\$2,542,985	\$30,099,350
Pumps/Motors	Old	5 Lift Pump Motor	SEWER	2-SPD-ROF	Elect.	Elect.	\$13,465,859	193,774	79,914	\$2,551,404	\$30,137,625
Hot Water	On	Hot Water	HGCA	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$13,475,059	193,945	79,914	\$2,552,202	\$30,141,187
Pumps/Motors	Old	8 Chiller Comp	CLNIC	Effic.-ROF	Elect.	Elect.	\$13,477,336	193,950	79,920	\$2,552,265	\$30,141,588
Pumps/Motors	Old	7 Chiller Comp	CLNIC	Effic.-ROF	Elect.	Elect.	\$13,477,842	193,952	79,923	\$2,552,290	\$30,141,749
Pumps/Motors	Old	4 AHU Fan	CLNIC	2-SPD-RI	Elect.	Elect.	\$13,478,428	193,958	79,921	\$2,552,360	\$30,141,934
Pumps/Motors	New	1 AHU Fan	ADM	Effic.-ROF	Elect.	Elect.	\$13,488,828	193,990	79,980	\$2,552,792	\$30,145,128
Weather.	Off	Heating	HGCB	Window Quilt	Nat. Gas (e)	Nat. Gas (e)	\$13,601,328	195,200	79,980	\$2,560,957	\$30,179,570
Weather.	On	Heating	HGSA	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$13,676,328	196,423	79,980	\$2,566,414	\$30,201,581
Weather.	On	Hot Water	HGSA	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$13,683,128	196,533	79,980	\$2,566,902	\$30,203,534
Weather.	Old	Heating	SHP	Ceiling Ins.	Fuel Oil	Fuel Oil	\$13,725,239	197,179	79,980	\$2,570,112	\$30,215,585
Weather.	Old	Heating	OTH	Ceiling Ins.	Fuel Oil	Fuel Oil	\$13,726,831	197,203	79,980	\$2,570,232	\$30,216,007
AC	Old/New	AC	NA	Com. WAC-1.2/10	Elect.	Elect.	\$13,759,681	197,288	80,205	\$2,572,943	\$30,224,400
Pumps/Motors	Old	11 Lift Pump Motor	SEWER	2-SPD-ROF	Elect.	Elect.	\$13,775,584	197,333	80,270	\$2,573,494	\$30,228,160
Pumps/Motors	New	3 Supply Fan	BAR	Effic.-ROF	Elect.	Elect.	\$13,778,381	197,347	80,296	\$2,573,692	\$30,229,358
Weather.	On	Heating	HGCL	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$13,914,881	199,493	80,296	\$2,583,195	\$30,263,040
Hot Water	On	Hot Water	HGCL	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$13,927,257	199,686	80,296	\$2,584,052	\$30,266,019
Weather.	On	Heating	HGLI	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$14,090,757	202,241	80,296	\$2,595,369	\$30,305,184
Pumps/Motors	New	3 Air Comp	SMA	Effic.-ROF	Elect.	Elect.	\$14,092,937	202,247	80,307	\$2,595,456	\$30,305,698
Hot Water	On	Hot Water	HGLI	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$14,095,927	202,247	80,307	\$2,595,477	\$30,305,160
Pumps/Motors	New	11 HW Pumps	ADM	Effic.-ROF	Elect.	Elect.	\$14,107,761	202,477	80,307	\$2,597,230	\$30,314,201
Hot Water	Off	Hot Water	HGCCO	Flue Damper	Propane	Propane	\$14,129,883	202,536	80,402	\$2,597,638	\$30,315,351
Furn. & Bldg.	Old	Heating	ADM	Furnace C New	Fuel Oil	Fuel Oil	\$14,134,983	202,604	80,402	\$2,597,638	\$30,315,351
Weather.	Old	Heating	BAR	Floor Ins.	Fuel Oil	Fuel Oil	\$14,587,283	206,905	80,402	\$2,629,625	\$30,415,424
Weather.	Old	Heating	CLB	Ceiling Ins.	Fuel Oil	Fuel Oil	\$14,626,032	207,469	80,402	\$2,632,426	\$30,423,948
Weather.	Old	Heating	CLB	Window Quilt	Fuel Oil	Fuel Oil	\$14,630,222	207,529	80,402	\$2,632,727	\$30,424,832
Weather.	Old	Heating	CLB	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$14,690,222	208,444	80,402	\$2,636,782	\$30,437,454
Hot Water	On	Hot Water	HGWI	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$14,695,662	208,527	80,402	\$2,637,148	\$30,438,566
Pumps/Motors	New	18 Ref Comp	MES	Effic.-ROF	Elect.	Elect.	\$14,699,662	208,539	80,409	\$2,637,264	\$30,439,315
Pumps/Motors	New	18 Ref Comp	CLB	Effic.-ROF	Elect.	Elect.	\$14,701,135	208,544	80,412	\$2,637,313	\$30,439,635
Furn. & Bldg.	Old	Heating	ASS	Boiler E-Old	Fuel Oil	Fuel Oil	\$14,735,695	209,817	80,412	\$2,640,021	\$30,445,936
Weather.	Off	Heating	HGCL	Window Quilt	Propane	Propane	\$14,810,695	209,817	80,412	\$2,645,783	\$30,459,261
Weather.	On	Heating	HGPA	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$14,866,945	210,646	80,412	\$2,645,459	\$30,468,840
Weather.	On	Heating	HGRE	Window Quilt	Nat. Gas (d)	Nat. Gas (d)	\$15,007,945	212,722	80,412	\$2,658,655	\$30,492,531
Weather.	Off	Heating	HGLO	Window Quilt	Propane	Propane	\$15,045,945	213,253	80,412	\$2,661,850	\$30,495,508
Hot Water	On	Hot Water	HGLO	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$15,055,045	213,328	80,412	\$2,662,181	\$30,500,348
Hot Water	On	Hot Water	HGRE	Vent Dampers	Nat. Gas (d)	Nat. Gas (d)	\$15,067,829	213,516	80,412	\$2,663,011	\$30,502,423

TABLE 3.6. (contd)

Energy Resource Opportunity Category	Area	End Use	HARD CODE (g)	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Cumulative Present Value of Installed Cost (1992 \$)	Cumulative Annual Energy Savings (MMBtu)	Cumulative Annual Demand and Savings (KW-mo)	Cumulative Value Of Annual Energy Savings (1992 \$)	Net Present Value of ERO (1992 \$)
Hot Water	Old	Hot Water	MES	New DWH	Propane	Net. Gas (d)	\$15,105,369	213,772	80,412	\$2,667,536	\$30,508,761
Pumps/Motors	New	19 Pump	CLB	Effic.-ROF	Elect.	Elect.	\$15,109,887	213,773	80,413	\$2,667,548	\$30,508,837
Pumps/Motors	New	18 Air Comp	MED	Effic.-ROF	Elect.	Elect.	\$15,111,405	213,776	80,420	\$2,667,595	\$30,509,058
Pumps/Motors	New	19 Pump	MES	Effic.-ROF	Elect.	Elect.	\$15,112,613	213,779	80,421	\$2,667,625	\$30,509,233
Weather.	Off	Heating	HGGC	Window Quilt	Propane	Propane	\$15,168,883	214,478	80,421	\$2,671,814	\$30,517,208
Pumps/Motors	New	6 Wz Tr Pump	MED	Effic.-ROF	Elect.	Elect.	\$15,178,604	214,485	80,469	\$2,672,108	\$30,518,553
Pumps/Motors	New	AHU Fan	ADM	CO2 Sensor	Elect.	Elect.	\$15,206,819	215,715	80,469	\$2,673,751	\$30,522,440
Pumps/Motors	New	3 Vac Pump	MED	Effic.-ROF	Elect.	Elect.	\$15,207,924	215,717	80,473	\$2,673,759	\$30,522,583
Weather.	On	Heating	HGRH	Window Quilt	Net. Gas (d)	Net. Gas (d)	\$15,387,924	218,192	80,473	\$2,679,779	\$30,522,583
Pumps/Motors	New	5 Vac Pump	MED	Effic.-ROF	Elect.	Elect.	\$15,387,924	218,192	80,473	\$2,679,779	\$30,522,583
Hot Water	On	Hot Water	HGRH	Vent Dampers	Net. Gas (d)	Net. Gas (d)	\$15,403,266	218,426	80,498	\$2,690,900	\$30,544,913
Pumps/Motors	New	1 HW Pump	MED	Effic.-ROF	Elect.	Elect.	\$15,403,266	218,426	80,498	\$2,690,900	\$30,544,913
Pumps/Motors	New	4 Vac Pump	MED	Effic.-ROF	Elect.	Elect.	\$15,406,983	218,429	80,503	\$2,691,889	\$30,547,543
Pumps/Motors	New	13 Chl Pump	MED	Effic.-ROF	Elect.	Elect.	\$15,406,983	218,432	80,510	\$2,691,978	\$30,547,543
Furn. & Bks.	Old	Heating	ADM	Boiler P New	Fuel Oil	Elect.	\$15,407,945	218,433	80,512	\$2,691,989	\$30,548,054
Hot Water	Old	Heating	ADM	Boiler P New	Fuel Oil	Elect.	\$15,444,385	219,677	80,512	\$2,701,991	\$30,562,438
Weather.	Off	Heating	MES	New DWH	Propane	Net. Gas (d)	\$15,583,848	219,917	80,512	\$2,704,141	\$30,566,502
Pumps/Motors	New	9 Cond Fan Ch	HGGN	Window Quilt	Propane	Elect.	\$15,665,848	220,778	80,512	\$2,709,320	\$30,573,892
Weather.	On	Heating	DGR	Effic.-ROF	Elect.	Elect.	\$15,665,848	220,778	80,518	\$2,709,320	\$30,573,892
Weather.	On	Heating	HGSU	Window Quilt	Net. Gas (d)	Net. Gas (d)	\$15,893,644	223,976	80,518	\$2,723,531	\$30,593,426
Weather.	On	Heating	HGYO	Window Quilt	Net. Gas (d)	Net. Gas (d)	\$16,015,144	225,635	80,521	\$2,730,871	\$30,603,381
Weather.	On	17 Air Comp	MED	Effic.-ROF	Elect.	Elect.	\$16,015,144	225,635	80,521	\$2,730,892	\$30,603,446
Weather.	Old	Heating	HGAD	Window Quilt	Net. Gas (d)	Net. Gas (d)	\$16,180,697	227,604	80,521	\$2,739,615	\$30,614,921
Weather.	Old	Heating	ADM	Window Quilt	Fuel Oil	Fuel Oil	\$16,319,122	229,641	80,521	\$2,749,743	\$30,627,386
Hot Water	On	Hot Water	HGSU	Vent Dampers	Net. Gas (d)	Net. Gas (d)	\$16,340,336	229,929	80,521	\$2,751,018	\$30,629,013
Weather.	On	Heating	HGYO	Vent Dampers	Net. Gas (d)	Net. Gas (d)	\$16,351,364	230,079	80,521	\$2,751,018	\$30,629,013
Weather.	On	Heating	HGSL	Window Quilt	Net. Gas (d)	Net. Gas (d)	\$16,492,354	231,992	80,521	\$2,760,156	\$30,640,631
Hot Water	On	Hot Water	HGAD	Vent Dampers	Net. Gas (d)	Net. Gas (d)	\$16,506,478	232,169	80,521	\$2,760,156	\$30,640,631
Hot Water	On	Hot Water	HGSL	Vent Dampers	Net. Gas (d)	Net. Gas (d)	\$16,518,262	232,342	80,521	\$2,761,707	\$30,642,512
Pumps/Motors	Old	1 Chiller Cond	CLNIC	Effic.-ROF	Elect.	Elect.	\$16,518,262	232,342	80,522	\$2,761,715	\$30,642,541
Pumps/Motors	New	21 AC Comp.	MES	Effic.-ROF	Elect.	Elect.	\$16,521,195	232,345	80,525	\$2,761,752	\$30,642,666
Pumps/Motors	New	21 AC Comp.	CLB	Effic.-ROF	Elect.	Elect.	\$16,522,230	232,346	80,527	\$2,761,788	\$30,642,718
Pumps/Motors	New	11 Sec. Pump	ASS	Effic.-ROF	Elect.	Elect.	\$16,523,077	232,347	80,530	\$2,761,782	\$30,642,748
Weather.	Old	Heating	REC	Window Quilt	Fuel Oil	Fuel Oil	\$16,530,979	232,444	80,530	\$2,762,263	\$30,642,961
Weather.	Old	Heating	ASS	Window Quilt	Fuel Oil	Fuel Oil	\$16,554,888	232,738	80,530	\$2,763,714	\$30,643,539
Furn. & Bks.	Old	Heating	MTH	Floor Ins.	Fuel Oil	Fuel Oil	\$16,555,596	232,744	80,530	\$2,763,757	\$30,643,551
Furn. & Bks.	Old	Heating	COM	Convert B-New	Fuel Oil	Net. Gas (d)	\$16,559,198	232,756	80,530	\$2,764,032	\$30,643,587
Furn. & Bks.	Old	Heating	ADM	Boiler P-Old	Fuel Oil	Net. Gas (d)	\$16,650,156	233,578	80,530	\$2,769,690	\$30,644,466

Notes:

- (a) These fixtures are not considered for sensor retrofits.
 (b) These fixtures are considered for sensor retrofits.
 (c) The option is combined with an adjacent option to make a complete measure.
 The value index has been calculated for the complete measure.
 (d) On-post natural gas rate.
 (e) Off-post natural gas rate.
 (f) The option has no installed cost. Therefore, no value index can be calculated.
 (g) For an explanation of the letters corresponding to the lighting EROs, see page 82.65.
 (h) The option has additional demand savings corresponding to a reduction in reactive demand.
 These savings are included in the Net Present Value.

TABLE 3.7. Total Savings, Costs, and NPV

Total Present Value of Installed Cost (1992 \$)	Total Present Value of O&M Savings (1992 \$)	Total Annual Energy Savings (MBtu)	Total Value of Annual Energy Savings (1992 \$)	Total Annual Demand Savings (kW-month)	Total Value of Annual Demand Savings (1992 \$)	Total Net Present Value of ERO (1992 \$)	Overall Value Index
16,650,156	6,619,467	233,578	2,327,098	80,530.0	442,592	30,644,466	1.84

TABLE 3.8. LCC Results - ERO Groups

Energy Resource Opportunity Category	End Use	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1992 \$)	PV of O&M Savings (1992 \$)	Annual Energy Savings (MMBtu)	Value of Annual Energy Savings (1992 \$)	Annual Demand Savings (KW-mo)	Value of Annual Demand Savings (1992 \$)	Total Net Present Value (1992 \$)	Value Index
Trans. & Dist.	Heating	Lower Temp.	Jones (HTHW)	Jones (HTHW)	\$0	\$0	39,000	\$187,506	NA	NA	\$2,824,128	(a)
Trans. & Dist.	Trans. & Dist.	CVR	Elect.	Elect.	\$800	\$0	2,529	\$37,510	1,306.6	\$7,194	\$28,493	786.62
Trans. & Dist.	Heating	Line Decomise.	Jones (HTHW)	Jones (HTHW)	\$6,130	\$0	3,760	\$16,108	NA	NA	\$265,421	43.30
Pumps/Motors	Trans. & Dist.	Downsize-RI	Elect.	Elect.	\$887	\$860	117	\$1,729	85.1	\$369	\$29,386	33.89
Pumps/Motors	Trans. & Dist.	PwrFCor a (d)	Elect.	Elect.	\$7,722	-\$235	53	\$781	28.6	\$148	\$254,867	32.98
Streetslights	Trans. & Dist.	Rdse OpHrs + Dimp 4&2-Lane	Elect.	Elect.	\$29,389	\$124,753	2,888	\$39,113	1,947.0	\$10,728	\$796,973	27.12
Trans. & Dist.	Heating	HPS Stritts	Elect.	Elect.	\$58,140	\$80,944	10,000	\$42,950	NA	NA	\$680,136	10.31
Trans. & Dist.	Heating	Pipe Insulation	Elect.	Elect.	\$58,140	\$80,944	2,124	\$28,473	1,456.6	\$8,028	\$636,600	9.23
Lighting	HIDA	Retrofit/Reduce Op. Hours	Elect.	Elect.	\$194,000	-\$517,532	29,802	\$18,380	31,200.0	\$171,912	\$1,382,873	7.03
Peak Shave	Peak Shave	DGEN-8	Elect.	Diesel	\$35,698	\$0	3,907	\$16,781	NA	NA	\$247,322	6.95
Controls	Heating	Night Set	Jones (HTHW)	Jones (HTHW)	\$30,492	\$0	2,883	\$14,331	NA	NA	\$211,326	6.93
Controls	Heating	FM System	Fuel Oil	Fuel Oil	\$14,278	\$0	535	\$7,782	-60.2	-\$332	\$85,985	6.02
Pumps/Motors	HTHW Pump	2-SPD-RI	Elect.	Elect.	\$39,066	-\$10,392	1,211	\$17,989	-202.8	-\$1,117	\$188,049	4.81
Pumps/Motors	AHU Fan	2-SPD-RI	Elect.	Elect.	\$2,571	-\$725	77	\$1,127	-4.1	-\$23	\$12,255	4.77
Pumps/Motors	Chill Pump	2-SPD-RI	Elect.	Elect.	\$630,740	\$2,182,954	3,482	\$60,825	1,398.1	\$7,703	\$2,476,116	4.67
Lighting	Exite	LED	Elect.	Elect.	\$40,194	-\$14,055	1,258	\$18,339	-282.4	-\$1,558	\$182,004	4.53
Pumps/Motors	AHU-1,2,3	2-SPD-RI	Elect.	Elect.	\$13,398	-\$4,886	419	\$6,111	-94.2	-\$519	\$80,638	4.53
Pumps/Motors	AHU-4	2-SPD-RI	Elect.	Elect.	\$29,170	-\$8,808	2,761	\$10,918	NA	NA	\$113,648	3.90
Fum. & Boilers	Heating	Add Pack.	Jones (HTHW)	Nat. Gas (a)	\$26,798	-\$9,370	587	\$10,063	-188.3	-\$1,038	\$91,172	3.40
Pumps/Motors	AHU-5,6	2-SPD-RI	Elect.	Elect.	\$85,339	-\$24,860	1,887	\$29,947	-483.3	-\$2,683	\$273,882	3.21
Pumps/Motors	MAHU	2-SPD-RI	Elect.	Elect.	\$123,532	\$0	6,069	\$30,172	NA	NA	\$395,576	3.12
Pumps/Motors	Weatherstrip	2-SPD-RI	Fuel Oil	Fuel Oil	\$42,828	-\$13,738	943	\$13,749	-185.2	-\$910	\$124,167	2.90
Pumps/Motors	SMF Fans	2-SPD-RI	Elect.	Elect.	\$17,800	-\$5,847	375	\$5,471	-33.3	-\$183	\$50,785	2.85
Pumps/Motors	Return Fan	2-SPD-RI	Elect.	Elect.	\$1,440	\$0	65	\$323	NA	NA	\$4,012	2.79
Weather.	Heating	Weather. Pack.	Fuel Oil	Fuel Oil	\$54,395	-\$4,124	775	\$10,822	649.0	\$3,578	\$141,345	2.60
Weather.	Heating	Install HPS 200	Elect.	Elect.	\$36,260	\$0	421	\$6,959	489.0	\$2,694	\$86,567	2.48
Weather.	Heating	Window Quilts	Elect.	Elect.	\$51,387	-\$18,352	989	\$14,412	-119.2	-\$657	\$123,892	2.41
Pumps/Motors	Sup Wtr Pmp	2-SPD-RI	Elect.	Elect.	\$11,972	-\$3,719	230	\$3,347	-44.2	-\$244	\$27,993	2.34
Pumps/Motors	MP HHCBN	2-SPD-RI	Elect.	Elect.	\$1,497	-\$485	29	\$418	-6.2	-\$34	\$3,446	2.30
Pumps/Motors	SF2	2-SPD-RI	Elect.	Elect.	\$5,142	-\$1,451	84	\$1,327	-16.4	-\$90	\$10,819	2.10
Pumps/Motors	Booster EXH	2-SPD-RI	Elect.	Elect.	\$3,123,671	\$2,582,579	23,821	\$419,014	15,398.2	\$84,833	\$6,551,533	2.10
Lighting	Incandescents	Compact Fluor./Sensor	Elect.	Elect.	\$111,374	-\$39,316	1,730	\$28,708	-678.6	-\$3,739	\$214,873	1.93
Pumps/Motors	Exh Fans	2-SPD-RI	Elect.	Elect.	\$4,564	-\$1,729	81	\$1,175	-22.2	-\$122	\$8,530	1.87
Pumps/Motors	Supply Fan	2-SPD-RI	Elect.	Elect.	\$1,250	-\$758	14	\$197	7.0	\$35	\$2,332	1.86
Pumps/Motors	Lift Pump Motor	Effic.-ROF	Elect.	Elect.	\$4,227,477	\$1,828,579	32,456	\$513,182	28,249.7	\$155,658	\$7,014,250	1.68
Lighting	Fluorescents	Weather/Sensor	Elect.	Elect.	\$139,008	\$0	2,840	\$19,256	NA	NA	\$205,835	1.48
Weather.	Heating	Weather. Pack.	Fuel Oil	Nat. Gas (b)	\$416,900	\$42,783	8,617	\$89,260	NA	NA	\$70,596	1.37
Fum. & Boilers	Boiler P New	Boiler P New	Elect.	Nat. Gas (a)	\$459	\$23	4	\$52	4.0	\$22	\$602	1.31
Fum. & Boilers	Dom Wtr Htr	Effic.-RI	Elect.	Elect.	\$712,510	\$151,758	15,338	\$98,692	NA	NA	\$914,321	1.28
Fum. & Boilers	Heating	Furnace C-Old	Fuel Oil	Nat. Gas (a)	\$28,600	\$0	251	\$3,808	94.0	\$518	\$32,293	1.13
Weather.	Heating	Ceiling Insulation - 40	Elect.	Elect.	\$893	-\$893	27	\$367	3.3	\$18	\$2,380	1.01
Pumps/Motors	Lift Pump Motor	2-SPD-RI	Elect.	Elect.	\$1,914	-\$669	25	\$364	-9.0	-\$50	\$1,841	0.96
Pumps/Motors	Wtr Pmp Cond	2-SPD-RI	Elect.	Elect.	\$208,224	\$0	5,149	\$22,811	NA	NA	\$200,291	0.96
Weather.	Heating	Weather. Pack.	Nat. Gas (a)	Nat. Gas (a)	\$288,040	\$30,674	5,248	\$36,988	NA	NA	\$274,364	0.95
Fum. & Boilers	Boiler P-Old	Boiler P-Old	Fuel Oil	Nat. Gas (a)	\$98,484	\$0	1,530	\$10,373	NA	NA	\$87,303	0.89
Fum. & Boilers	Heating	Flue Damper	Nat. Gas (b)	Nat. Gas (b)	\$38,592	\$0	780	\$4,691	NA	NA	\$33,322	0.86
Weather.	Heating	Weather. Pack.	Propane	Propane	\$434,155	\$200,191	5,839	\$54,099	NA	NA	\$406,395	0.82
Hot Water	Hot Water	New DWH	Fuel Oil	Nat. Gas (a)	\$1,276	-\$446	13	\$211	3.0	-\$17	\$1,021	0.80
Pumps/Motors	Chill Supply	2-SPD-RI	Elect.	Elect.								

TABLE 3.8. (contd)

Energy Resource Opportunity Category	End Use	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Present Value of Installed Cost (1992 \$)	PV of O&M Savings (1992 \$)	Annual Energy Savings (MMBtu)	Value of Annual Energy Savings (1992 \$)	Annual Demand Savings (KW-mo)	Value of Annual Demand Savings (1992 \$)	Total Net Present Value (1992 \$)	Value Index
Pumps/Motors	Prim Pump	2-SPD-RI	Elect.	Elect.	\$2,562	-\$992	35	\$605	-23.9	-\$132	\$1,804	0.71
Pumps & Motors	AHU Fan	CO2 Sensor	Elect.	Elect.	\$58,430	-\$174,584	2,747	\$17,199	0.0	\$0	\$37,839	0.67
Furn. & Boilers	Heating	Furnace C New	Fuel Oil	Nat. Gas (a)	\$1,341,700	\$276,070	17,557	\$130,563	NA	NA	\$770,564	0.57
Furn. & Boilers	Heating	Furn-C	Fuel Oil	Nat. Gas (a)	\$28,500	\$12,108	280	\$2,409	NA	NA	\$15,656	0.55
Pumps/Motors	Chiller	Effio.-ROF	Elect.	Elect.	\$5,776	-\$880	42	\$332	25.8	\$78	\$3,142	0.54
Weather.	Heating	Window Quilt	Nat. Gas (b)	Nat. Gas (b)	\$1,088,000	\$0	13,254	\$89,869	NA	NA	\$523,255	0.48
Pumps/Motors	Ref Comp	Effio.-ROF	Elect.	Elect.	\$12,749	-\$1,863	76	\$602	48.0	\$145	\$5,874	0.45
Weather.	Heating	Floor Ins.	Fuel Oil	Fuel Oil	\$87,503	\$0	1,485	\$7,383	NA	NA	\$37,085	0.42
Hot Water	Hot Water	Fue Damper	Propane	Propane	\$27,336	\$0	418	\$2,502	NA	NA	\$11,018	0.40
Pumps/Motors	Exh Fans	2-SPD-ROF	Elect.	Elect.	\$31,059	-\$19,201	377	\$3,535	-153.9	-\$483	\$10,975	0.35
Pumps/Motors	Supply Pmp	Effio.-ROF	Elect.	Elect.	\$653	-\$83	2	\$114	4.1	\$12	\$194	0.35
Pumps/Motors	HW Pumps	Effio.-ROF	Elect.	Elect.	\$42,890	-\$4,534	178	\$1,415	179.9	\$542	\$14,890	0.34
Pumps/Motors	AHU Fan	Effio.-ROF	Elect.	Elect.	\$20,800	-\$2,099	72	\$572	118.2	\$356	\$7,012	0.34
Pumps/Motors	Chiller Comp	Effio.-ROF	Elect.	Elect.	\$1,783	-\$275	7	\$61	8.6	\$28	\$682	0.33
Pumps/Motors	Lift Pump Motor	2-SPD-ROF	Elect.	Elect.	\$817	-\$478	10	\$71	0.9	\$3	\$243	0.30
Weather.	Heating	Ceiling Ins.	Fuel Oil	Fuel Oil	\$47,883	\$0	730	\$3,630	NA	NA	\$13,357	0.28
AC	AC	Com. WAC-1.2/10	Elect.	Elect.	\$31,850	\$0	88	\$1,470	225.2	\$1,241	\$8,353	0.28
Pumps/Motors	Supply Fan	Effio.-ROF	Elect.	Elect.	\$14,484	-\$1,414	40	\$321	64.6	\$195	\$3,854	0.25
Pumps/Motors	Air Comp	Effio.-ROF	Elect.	Elect.	\$9,297	-\$1,488	24	\$212	46.7	\$141	\$1,999	0.21
Furn. & Boilers	Heating	Boiler E-Old	Fuel Oil	Nat. Gas (a)	\$34,580	\$4,843	315	\$2,708	NA	NA	\$6,301	0.18
Weather.	Heating	Window Quilt	Fuel Oil	Fuel Oil	\$217,797	\$0	3,065	\$15,238	NA	NA	\$39,295	0.18
Pumps/Motors	Vac Pump	Effio.-ROF	Elect.	Elect.	\$9,598	-\$1,454	24	\$195	40.9	\$123	\$1,668	0.17
Weather.	Heating	Window Quilt	Nat. Gas (a)	Nat. Gas (a)	\$1,828,750	\$0	24,030	\$106,451	NA	NA	\$279,653	0.17
Hot Water	Hot Water	Vent Dampers	Nat. Gas (a)	Nat. Gas (a)	\$147,492	\$0	2,168	\$9,805	NA	NA	\$24,514	0.17
Hot Water	Hot Water	New DWH	Propane	Nat. Gas (a)	\$41,540	\$0	258	\$4,525	NA	NA	\$6,338	0.15
Weather.	Heating	Window Quilt	Propane	Propane	\$245,250	\$0	3,048	\$18,324	NA	NA	\$36,867	0.15
Pumps/Motors	Pump	Effio.-ROF	Elect.	Elect.	\$1,725	-\$168	4	\$35	2.6	\$8	\$250	0.15
Pumps/Motors	Wtr Tr Pump	Effio.-ROF	Elect.	Elect.	\$9,741	-\$1,538	19	\$151	47.2	\$142	\$1,348	0.14
Pumps/Motors	Chill Pump	Effio.-ROF	Elect.	Elect.	\$982	-\$103	2	\$15	2.0	\$6	\$102	0.11
Pumps/Motors	Cond Fan Ch	Effio.-ROF	Elect.	Elect.	\$3,798	-\$370	7	\$67	5.6	\$17	\$359	0.09
Pumps/Motors	Chiller Cond	Effio.-ROF	Elect.	Elect.	\$518	-\$50	1	\$6	0.8	\$2	\$29	0.06
Pumps/Motors	AC Comp.	Effio.-ROF	Elect.	Elect.	\$3,451	-\$337	4	\$37	5.1	\$15	\$177	0.05
Pumps/Motors	Sec. Pump	Effio.-ROF	Elect.	Elect.	\$846	-\$109	1	\$5	3.1	\$9	\$30	0.04
Furn. & Boilers	Heating	Convert B-New	Fuel Oil	Nat. Gas (a)	\$3,800	\$807	12	\$275	NA	NA	\$36	0.01

Notes:

(a) On-post natural gas rate.

(b) Off-post natural gas rate.

(c) This option has no installed cost. Therefore, no value index can be calculated.

(d) This option has additional demand savings corresponding to a reduction in reactive demand.

These savings are included in the Net Present Value.

TABLE 3.9. Cumulative LCC Results - ERO Groups

Energy Resource Opportunity Category	End Use	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Cumulative Present Value of Installed Cost (1992 \$)	Cumulative Annual Energy Savings (MBtu)	Cumulative Annual Demand Savings (KW-mo)	Cumulative Value Of Annual Energy and Demand Savings (1992 \$)	Cumulative Net Present Value of ERO (1992 \$)
Trans. & Dist.	Heating	Lower Temp.	Jones (HTHW)	Jones (HTHW)	\$0	39,000	0	\$167,505	\$2,824,128
Trans. & Dist.	Trans. & Dist.	CVR	Elect.	Elect.	\$800	41,529	1,308	\$212,209	\$3,452,621
Pumps/Motors	Heating	Line Decomias.	Jones (HTHW)	Jones (HTHW)	\$6,930	45,279	1,308	\$228,316	\$3,718,042
Pumps/Motors	Trans. & Dist.	Downsize-RI	Elect.	Elect.	\$7,797	45,398	1,371	\$230,403	\$3,747,427
Trans. & Dist.	Trans. & Dist.	Pwr/Cor a (d)	Elect.	Elect.	\$15,519	45,449	1,397	\$231,330	\$4,002,084
Streetlights	HPS Stritts	Rdce Op/Hrs + Dimp 4&2-Lane	Elect.	Elect.	\$44,908	48,338	3,344	\$281,171	\$4,799,058
Trans. & Dist.	Heating	Pipe Insulation	Jones (HTHW)	Jones (HTHW)	\$108,908	58,338	3,344	\$324,121	\$5,459,193
Lighting	HIDe	Retrofit/Reduce Op. Hours	Elect.	Elect.	\$167,048	60,482	4,801	\$360,620	\$6,995,793
Peak-Shave Controls	Peak-Shave	DGEN-8	Elect.	Diesel	\$381,048	30,659	38,001	\$550,892	\$7,358,686
Controls	Heating	Night Set	Jones (HTHW)	Jones (HTHW)	\$396,648	34,566	38,001	\$567,873	\$7,605,988
Controls	Heating	FM System	Fuel Oil	Fuel Oil	\$427,138	37,449	38,001	\$582,004	\$7,817,313
Pumps/Motors	HTHW Pump	2-SPD-RI	Elect.	Elect.	\$441,414	37,984	35,941	\$589,464	\$7,903,298
Pumps/Motors	AHU Fan	2-SPD-RI	Elect.	Elect.	\$480,479	39,196	35,738	\$606,336	\$8,081,345
Pumps/Motors	Chill Pump	2-SPD-RI	Elect.	Elect.	\$483,060	39,272	36,734	\$607,441	\$8,103,601
Lighting	Exits	LED	Elect.	Elect.	\$1,013,790	42,754	37,132	\$665,969	\$10,579,716
Pumps/Motors	AHU-1,2,3	2-SPD-RI	Elect.	Elect.	\$1,063,984	44,012	38,849	\$682,752	\$10,761,720
Pumps/Motors	AHU-4	2-SPD-RI	Elect.	Elect.	\$1,067,382	44,432	38,755	\$688,344	\$10,822,358
Fum. & Boilers	Heating	Add Pack.	Elect.	Elect.	\$1,096,562	47,193	38,755	\$699,261	\$10,936,005
Pumps/Motors	AHU-5,6	2-SPD-RI	Elect.	Elect.	\$1,123,348	47,780	38,567	\$708,307	\$11,027,177
Pumps/Motors	MAHU	2-SPD-RI	Elect.	Elect.	\$1,208,687	49,667	38,084	\$735,591	\$11,301,069
Weather.	Heating	Weatherstrip	Fuel Oil	Fuel Oil	\$1,332,219	55,736	38,084	\$765,763	\$11,686,634
Pumps/Motors	SMF Fans	2-SPD-RI	Elect.	Elect.	\$1,376,045	56,879	36,918	\$778,602	\$11,810,801
Pumps/Motors	Return Fan	2-SPD-RI	Elect.	Elect.	\$1,392,845	57,065	36,885	\$783,889	\$11,881,586
Weather.	Heating	Weather. Pack.	Fuel Oil	Fuel Oil	\$1,394,285	57,120	36,885	\$784,212	\$11,885,598
Streetlights	Mero Stritts	Install HPS 200	Elect.	Elect.	\$1,448,680	57,894	36,534	\$798,410	\$12,006,943
Pumps/Motors	Sup Wtr Pmp	Window Quilts	Elect.	Elect.	\$1,483,930	58,318	37,023	\$807,084	\$12,093,510
Pumps/Motors	MP HHCEN	2-SPD-RI	Elect.	Elect.	\$1,535,317	59,305	36,904	\$820,819	\$12,217,402
Pumps/Motors	SF2	2-SPD-RI	Elect.	Elect.	\$1,547,289	59,534	36,860	\$823,922	\$12,245,395
Pumps/Motors	Booster EXH	2-SPD-RI	Elect.	Elect.	\$1,548,786	59,563	36,853	\$824,307	\$12,248,841
Lighting	Incandescents	2-SPD-RI	Elect.	Elect.	\$1,553,928	59,647	36,837	\$825,544	\$12,259,660
Pumps/Motors	Exh Fans	Compact Fluor./Sensor	Elect.	Elect.	\$4,677,599	83,268	52,233	\$1,329,390	\$18,811,193
Pumps/Motors	Supply Fan	2-SPD-RI	Elect.	Elect.	\$4,788,973	84,998	51,555	\$1,355,359	\$19,026,068
Pumps/Motors	Lift Pump Motor	Effic.-ROF	Elect.	Elect.	\$4,793,537	85,079	51,532	\$1,356,412	\$19,034,595
Lighting	Fluorescents	Retrofit/Sensor	Elect.	Elect.	\$9,022,265	117,549	51,539	\$1,356,645	\$26,051,178
Fum. & Boilers	Heating	Weather. Pack.	Nat. Gas (b)	Nat. Gas (b)	\$9,181,273	120,389	79,789	\$2,025,482	\$26,257,013
Pumps/Motors	Dom Wtr Htr	Boiler P New	Fuel Oil	Nat. Gas (a)	\$9,578,173	129,006	79,789	\$2,044,738	\$26,827,609
Fum. & Boilers	Heating	Effic.-RI	Elect.	Elect.	\$9,578,632	129,009	79,793	\$2,113,998	\$26,828,211
Weather.	Heating	Fumace C-Old	Fuel Oil	Nat. Gas (a)	\$10,291,142	144,347	79,793	\$2,212,763	\$27,742,532
Pumps/Motors	Lift Pump Motor	Ceiling Insulation - 40	Elect.	Elect.	\$10,319,742	144,598	79,887	\$2,217,089	\$27,774,825
Pumps/Motors	Wtr Pmp Cond	2-SPD-RI	Elect.	Elect.	\$10,322,091	144,625	79,890	\$2,217,474	\$27,777,205
Weather.	Heating	Weather. Pack.	Nat. Gas (a)	Nat. Gas (a)	\$10,532,229	149,799	79,881	\$2,240,600	\$27,979,337
Fum. & Boilers	Heating	Boiler P-Old	Fuel Oil	Nat. Gas (a)	\$10,820,269	155,047	79,881	\$2,277,587	\$28,253,701
Fum. & Boilers	Heating	Fuke Damper	Nat. Gas (b)	Nat. Gas (b)	\$10,918,733	156,577	79,881	\$2,287,960	\$28,341,004
Weather.	Hot Water	Weather. Pack	Propane	Propane	\$10,957,325	157,367	79,881	\$2,292,651	\$28,374,326
Pumps/Motors	Chill Supply	New DWH	Fuel Oil	Nat. Gas (a)	\$11,451,481	163,198	79,881	\$2,346,750	\$28,780,721
		2-SPD-RI	Elect.	Elect.	\$11,452,757	163,209	79,878	\$2,346,945	\$28,781,742

TABLE 3.9. (contd)

Energy Resource Opportunity Category	End Use	Energy Resource Opportunity	Existing Fuel	Resulting Fuel	Cumulative Present Value of Installed Cost (1992 \$)	Cumulative Annual Energy Savings (MBtu)	Cumulative Annual Demand (KW-mo)	Cumulative Value Of Annual Energy and Demand Savings (1992 \$)	Cumulative Net Present Value of ERO (1992 \$)
Pumps/Motors	Prim Pump	2-SPD-RI	Elect.	Elect.	\$11,455,309	163,244	79,855	\$2,347,318	\$28,783,546
Pumps & Motors	AHU Fan	CO2 Sensor	Elect.	Elect.	\$11,511,739	165,990	79,855	\$2,364,516	\$28,821,185
Furn. & Boilers	Heating	Furnace C New	Fuel Oil	Nat. Gas (a)	\$12,853,439	183,547	79,855	\$2,495,079	\$29,591,779
Furn. & Boilers	Heating	Furn-C	Fuel Oil	Nat. Gas (a)	\$12,881,939	183,828	79,855	\$2,497,489	\$29,607,435
Pumps/Motors	Chiller	Effic.-ROF	Elect.	Elect.	\$12,887,715	183,869	79,880	\$2,497,898	\$29,610,577
Weather.	Heating	Window Quilt	Nat. Gas (b)	Nat. Gas (b)	\$13,973,715	197,123	79,880	\$2,587,757	\$30,133,843
Pumps/Motors	Ref Comp	Effic.-ROF	Elect.	Elect.	\$13,986,464	197,189	79,928	\$2,588,504	\$30,139,516
Weather.	Heating	Floor Ins.	Fuel Oil	Fuel Oil	\$14,073,967	198,884	79,928	\$2,595,887	\$30,176,582
Hot Water	Hot Water	Flue Damper	Propane	Propane	\$14,101,303	199,100	79,928	\$2,598,388	\$30,187,600
Pumps/Motors	Exh Fans	2-SPD-ROF	Elect.	Elect.	\$14,132,363	199,478	79,774	\$2,601,480	\$30,198,575
Pumps/Motors	Supply Pmp	Effic.-ROF	Elect.	Elect.	\$14,132,915	199,478	79,779	\$2,601,487	\$30,198,769
Pumps/Motors	HW Pumps	Effic.-ROF	Elect.	Elect.	\$14,175,595	199,658	79,958	\$2,603,444	\$30,213,480
Pumps/Motors	AHU Fan	Effic.-ROF	Elect.	Elect.	\$14,196,398	199,727	80,077	\$2,604,371	\$30,220,472
Pumps/Motors	Chiller Comp	Effic.-ROF	Elect.	Elect.	\$14,198,178	199,735	80,085	\$2,604,458	\$30,221,054
Pumps/Motors	Lift Pump Motor	2-SPD-ROF	Elect.	Elect.	\$14,198,995	199,744	80,088	\$2,604,532	\$30,221,297
Weather.	Heating	Ceiling Ins.	Fuel Oil	Fuel Oil	\$14,246,888	200,474	80,088	\$2,608,162	\$30,234,654
AC	AC	Com. WAC-1.2/10	Elect.	Elect.	\$14,278,738	200,560	80,311	\$2,610,873	\$30,243,047
Pumps/Motors	Supply Fan	Effic.-ROF	Elect.	Elect.	\$14,293,232	200,800	80,376	\$2,611,389	\$30,246,701
Pumps/Motors	Air Comp	Effic.-ROF	Elect.	Elect.	\$14,302,530	200,825	80,423	\$2,611,742	\$30,248,700
Furn. & Boilers	Heating	Boiler E-Old	Fuel Oil	Nat. Gas (a)	\$14,337,080	200,840	80,423	\$2,614,450	\$30,255,002
Weather.	Heating	Window Quilt	Fuel Oil	Fuel Oil	\$14,554,887	204,006	80,423	\$2,629,687	\$30,294,297
Pumps/Motors	Vac Pump	Effic.-ROF	Elect.	Elect.	\$14,564,485	204,028	80,464	\$2,630,004	\$30,295,964
Weather.	Heating	Window Quilt	Nat. Gas (a)	Nat. Gas (a)	\$16,191,235	228,058	80,464	\$2,738,455	\$30,575,618
Hot Water	Hot Water	Vent Dampers	Nat. Gas (a)	Nat. Gas (a)	\$16,338,727	230,228	80,464	\$2,746,080	\$30,600,132
Hot Water	Hot Water	New DWH	Propane	Nat. Gas (a)	\$16,380,267	230,482	80,464	\$2,750,584	\$30,608,470
Weather.	Heating	Window Quilt	Propane	Propane	\$16,625,517	233,529	80,464	\$2,768,909	\$30,642,137
Pumps/Motors	Pump	Effic.-ROF	Elect.	Elect.	\$16,627,242	233,533	80,468	\$2,768,951	\$30,642,387
Pumps/Motors	Wtr Tr Pump	Effic.-ROF	Elect.	Elect.	\$16,636,984	233,552	80,513	\$2,769,245	\$30,643,733
Pumps/Motors	Chill Pump	Effic.-ROF	Elect.	Elect.	\$16,637,945	233,554	80,515	\$2,769,268	\$30,643,836
Pumps/Motors	Cond Fan Ch	Effic.-ROF	Elect.	Elect.	\$16,641,741	233,561	80,521	\$2,769,340	\$30,644,194
Pumps/Motors	Chiller Cond	Effic.-ROF	Elect.	Elect.	\$16,642,259	233,562	80,522	\$2,769,348	\$30,644,233
Pumps/Motors	AC Comp.	Effic.-ROF	Elect.	Elect.	\$16,645,710	233,568	80,527	\$2,769,400	\$30,644,400
Pumps/Motors	Sec. Pump	Effic.-ROF	Elect.	Elect.	\$16,646,558	233,568	80,530	\$2,769,415	\$30,644,430
Furn. & Boilers	Heating	Convert B-New	Fuel Oil	Nat. Gas (a)	\$16,650,156	233,578	80,530	\$2,769,890	\$30,644,468

Notes:

- (a) On-post natural gas rate.
 (b) Off-post natural gas rate.
 (c) This option has no installed cost. Therefore, no value index can be calculated.
 (d) This option has additional demand savings corresponding to a reduction in reactive demand.
 These savings are included in the Net Present Value.

TABLE 3.10. Fuel Balance Table

Fuel	Quantity Conserved (MBtu)	New Load (MBtu)	Net Conservation (MBtu)
Electricity	94,418	0	94,418
Fuel Oil	310,861	0	310,861
Natural Gas	48,970	249,995	-201,025
High Temp Hot Water	66,397	0	-66,397
Propane	6,378	0	6,378
Diesel	0	43,451	-43,451
Total	527,024	293,446	233,578

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