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FEDERAL ENERGY DECISION SCREENING (FEDS) PROCESS AT FORT DRUM, NEW YORK

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ABSTRACT

The federal energy manager has been directed by the Comprehensive Energy Policy Act of 1992 (EPAct) to reduce energy consumption by 20% from 1985 levels by the year 2000. However, the tools and funding to capture this resource in a cost-effective manner have not been provided. In an effort to assist federal agencies in meeting EPAct requirements, the Pacific Northwest Laboratory (PNL)[a] has been tasked by the U.S. Army Forces Command (FORSCOM) to identify, evaluate, and acquire all cost-effective energy projects at selected federal facilities. PNL has developed and applied the Federal Energy Decision Screening (FEDS) methodology at the Fort Drum FORSCOM facility near Watertown, New York. The FEDS methodology is a systematic approach to evaluating energy opportunities that result in a roadmap to significantly reduce energy use in a planned, rational, cost justified fashion over a 5 to 10 year period. At Fort Drum, the net present value (NPV) of the installed cost of all cost-effective energy resource opportunities (EROs) is over $16 million (1992 $). The NPV of the savings associated with this investment is nearly $47 million (1992 $), for an overall NPV of approximately $31 million. By implementing all the cost-effective EROs, Fort Drum will reduce annual energy use by over 230,000 MBtu, or 15%. Annual energy expenditures will decrease by over $2.4 million, or a 20% reduction.

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INTRODUCTION

The Comprehensive Energy Policy Act of 1992 (EPAct) [1] directs federal agencies to reduce energy consumption by 20% from 1985 levels by the year 2000. In an effort to assist federal agencies in meeting EPAct requirements, PNL has been tasked by the U.S. Army Forces Command (FORSCOM), as the lead laboratory supporting the U.S. Department of Energy (DOE) Federal Energy Management Program (FEMP), to identify, evaluate, and acquire all cost-effective energy projects at selected federal facilities. PNL has developed and applied the Federal Energy Decision Screening (FEDS) methodology at the Fort Drum FORSCOM facility near Watertown, New York. This paper presents a description of the FEDS process as applied to a case study of Fort Drum, the complete results of which are documented in PNL-8424 [2,3].

FEDERAL ENERGY MANAGEMENT

Some of the most difficult problems that a federal site has in reducing its energy consumption in a cost-effective manner revolve around understanding where the energy is being used, and what technologies could be employed to decrease the energy use. Many large federal sites have one or two meters to track electric energy use for several thousand buildings and numerous industrial processes. Even where meters are available on individual buildings or family housing units, the meters are not consistently read. When the federal energy manager has been able to identify high energy users, he or she may not have the background, training, or resources to determine the most cost-effective options for reducing this energy use. This can lead to selection of suboptimal choices that prevent the site from achieving the full energy savings potential.

The FEDS process is a systematic approach to evaluating energy opportunities that 1) identifies the building groups and end uses that use the most energy (not just have the greatest energy-use intensity), and 2) evaluates the numerous options for retrofit or installation of new technology that will result in the selection of the most cost-effective technologies. In essence, FEDS provides the federal energy manager with a roadmap to significantly reduce energy use in a planned, rational, cost-effective fashion that is not biased by the constraints of the typical funding sources available to federal sites. The results from FEDS can easily be turned into a five- to ten-year energy management plan that identifies where to start and how to proceed in order to reach the mandated energy consumption targets.

Another part of the FEDS process is to work with electric and fossil fuel utilities to develop a demand-side management (DSM) program that supports the site's energy management goals. Federal sites are authorized and encouraged to actively participate in DSM programs offered by regulated public utilities. The goal of FEDS is to negotiate a DSM program where the utility will:

- finance 100% of the installed cost of the cost-effective energy projects,
- enlist the services of an energy services contractor (ESCO) to design, install, maintain, and evaluate the equipment acquired in these projects, and
- cost share a substantial portion of the total cost installed cost.

FEDS: THE FIVE-STEP PROCESS

The FEDS process consists of five distinct steps: screening, analysis, negotiation, implementation, and verification. The process begins with the screening step in which the project's potential viability is determined. The analysis step identifies, evaluates, and prioritizes EROs at the site. The negotiation step includes a review of the integrated resource plan (IRP) developed in the analysis step, along with utility DSM programs and other federal agency funding sources, to determine a strategy for implementation. The implementation step involves enlisting the assistance of an ESCO who will conduct detailed audits and install technologies. The final step verifies energy savings through an established metering program.

Step 1: Screening

The purpose of the screening step is to provide information about the project's viability, from which the initial decision to proceed with a FEDS assessment will be made. A FEDS project manager is contacted by a prospective federal client with a need to improve energy efficiency at a site. The client will most likely be the facility energy manager and/or the major command. Federal client management supports the assessment with staff, data, and other resources. Following up this contact, the FEDS manager initiates conversations with the prospective federal client and the utility servicing the federal client. Interest is identified and groundwork layed for subsequent interaction.

Preliminary information gathered through phone calls, meetings, and a site visit assist in the initial identification and characterization of potential cost-effective energy projects. Information to be collected includes facility location and purpose; energy consumption and price by fuel type; and quantity, operation schedule, and age of facility buildings and energy-consuming equipment (e.g., boilers, furnaces, pumps). In addition, the utility is studied to understand how its resource mix and system energy balance will respond to changes in future load. This information includes resource generating capacity, system load characteristics (e.g., utilization factors for residential, commercial, industrial, and federal customers), and avoided energy costs. From this, a preliminary estimate of savings potential is made.

To complete this step, an evaluation of the project's potential viability is assessed by considering the energy savings potential for the federal customer and utility interest in developing a prototype DSM program for this customer. If the decision is made to continue beyond the screening phase, a schedule for assessment deliverables is established and the analysis step begins.

Step 2: Analysis

A detailed study is conducted in the analysis step to identify, evaluate, and prioritize energy resource opportunities (EROs) available to the site. First, energy consumption is characterized by fuel type, energy end use, and building type. This assessment of baseline energy use is more rigorous than the rudimentary analysis of the screening step, as it considers a more comprehensive set of data.

An initial data request is sent to and reviewed by the client. This list includes specific electronic and paper documents such as real property lists; scope and distribution of energy conservation projects; fuel consumption records; and inventories indicating model, capacity, age, and operating hours for energy-consuming equipment. Following up this data request is a site visit to collect additional information about typical buildings and equipment. This first-hand inspection allows one to become more familiar with the facility and the specific needs at each site. In addition, evaluation of metered data provides important information useful in determining electric consumption and energy-use intensities for various site facilities. Collecting this data is an iterative process which requires extensive collaboration and review of data with site personnel.

Second, EROs are identified and evaluated using the federally mandated life-cycle cost (LCC) methodology. Based on engineering experience with other energy assessments, discussion with site personnel and external expert energy consultants, promising EROs are selected from a master list for further LCC evaluation. This preliminary screening considers technology maturity; resource conservation potential; economic feasibility; utility incentives, rates, and cost sharing level; impact on mission-critical function; data availability; climate; condition of site equipment and buildings; and site preference and experience.

With new experience gained at each site, the master ERO list expands. ERO categories include: boilers, furnaces, domestic hot water (DHW), building envelope, fans, pumps, motors, compressors, air conditioning, lighting, transmission and distribution, process-related energy use, fuel-switching and alternative or renewable energy. The performance of each ERO is evaluated for energy saving based on thermodynamic, heat transfer, and other engineering calculations. Baseline energy use information and assumptions such as climate, operating hours, equipment condition, and age are inputs for these calculations. Installed cost calculations are determined using current product literature, published costs, and vendor quotes. Environmental impact of each ERO is also considered. Next, the LCC economic analysis employs a methodology detailed in and mandated by 10 CFR Part 436 [4] to determine the ERO's net present value (NPV).

Finally, EROs are prioritized in a fuel-neutral manner by NPV. It is this ranking which defines the optimal return on site and utility investment and from which negotiations can begin.

Step 3: Negotiation

The negotiation step strives to produce a contract that matches the utility's program offering with that proposed by the federal customer. It begins with an iterative review and refining process involving the federal client and servicing utility. Efficiency improvement calculations and estimates of individual ERO cost-effectiveness in the IRP are agreed upon and accepted as an accurate representation of potential savings. This review also examines the willingness of the utility to modify, if necessary, its DSM program offering to include the range of EROs proposed by the federal customer.

Broader input from federal and/or private organizations may be necessary. For example, Public Utility/Public Service Commissions (PUC/PSCs) may be called upon to encourage the utility to develop an implementation plan acceptable to the federal customer. In addition to utility negotiation of implementing specific EROs or groups of EROs, contracting requirements for ESCO services are discussed. Difficult technical and procedural issues are resolved. The result is a successful contract between the utility and federal customer which determines a strategy for implementation.

Step 4: Implementation

This step is closely associated with the preceding negotiation and results in installation of equipment. The negotiated contract is developed using a systematic, objective, and rational approach to install technologies in the most cost-effective manner. The selection and ordering of projects considers: NPVs of individual and groups of EROs, verification requirements of the utility and federal customer, expected energy savings, impact on mission-critical requirements, and available funding from different sources. Project implementation periods may range from five to ten years. From this contract and using the FEDS assessment as a guide, the contracted services of one or more ESCOs are enlisted in a competitive bidding process. The ESCO conducts detailed energy-use audits, and designs, procures, installs, and maintains the new and retrofit equipment. The federal customer approves and inspects all ESCO projects. The utility pays the ESCO for the installed cost of the project. The federal customer pays the utility so it may recover its portion of the project cost.

Step 5: Verification

This final step of the FEDS process relates back to the mandate of the EPAct. By evaluating energy consumption after successful completion of the implementation step and then comparing it with consumption prior to implementation (baselined in the analysis step), the federal customer will be able to verify how successfully the statutory energy savings requirements of the EPAct are being met.

Utilities will direct the verification process and will rely on fuel consumption, metering programs, and other accurate methods established with the assistance of the contracted ESCO. Initial assessments of energy savings upon implementation as well as detailed tracking of retained energy savings over time will be necessary to meet utility and DoD retained energy savings requirements. The actual difference between what would have been consumed by pre-implementation equipment and what was actually consumed by post-implementation equipment cannot be directly measured. One can only measure pre-implementation and post-implementation energy consumption and extrapolate pre-implementation consumption to the post-implementation period using weather, building occupancy, and other factors to normalize the separate periods.

FEDS AT FORT DRUM, NEW YORK

Fort Drum provides training and support to the 10th Mountain Division of the U.S. Army, and had over 10,000 active military personnel in 1991. Most of these military personnel and their dependents live in housing provided by the Army either on the Fort, or in leased housing off post. In addition, the Fort employed over 1,500 civilian personnel in 1991 that do not live in military housing. Including all the military dependents, the total Fort population can exceed 30,000 people during the working week.

The Fort was divided into six major categories for the FEDS analysis. These categories include old post commercial, new post commercial, on-post housing, on-post utility (including exterior lighting, pumping, and transmission and distribution losses), off-post housing, and the off-post commercial (one large office complex is located in Syracuse, New York). The old post commercial consists primarily of about 700 one- and two-story frame structures constructed in the 1940s. Many of these facilities have been renovated over the years with metal siding, wall and attic insulation, storm windows, fluorescent lighting, and fuel oil furnaces and boilers. These old post facilities are used for barracks, office space, dining, warehouse/storage, recreational purposes, medical services, etc. The new post commercial was constructed between 1985 and 1988, and consists of about 200 large, concrete block and brick buildings. Most of these facilities are used as barracks, office space, dining, motor vehicle maintenance, recreation, retail sales, motel, and data processing. These new post facilities are heated with high-temperature hot water (HTHW) from a central, coal-fired co-generation plant operated by a private party.

The off- and on-post housing consists of single family, 2- and 4- plexes, and multi-apartment complexes, with over 4,000 separate buildings. Most of these units are relatively new, and use natural gas or propane for heating and cooking. Some of the older units are all-electric.

Energy Use Baseline

The first step in evaluating energy savings opportunities at Fort Drum was to gather information on the energy usage across the Fort. On the electric side, there were four sources of electric metering and consumption data: utility whole post meter readings, off-post housing meters, on-post meters (some buildings, areas, other), and substation feeder readings made by PNL. The utility readings and housing meters were used to determine the total electric energy consumption by building category (i.e., old post commercial, etc.). The substation feeder readings were collected for over a year in 15-minute intervals, and gave insight into the time of day consumption at the Fort (see Figure 2). This feeder data, along with estimates of energy-use intensities (EUIs), were used to reconcile the energy consumption by building type and end-use technology (lighting, heating, cooling, etc.). The energy that could not be directly associated with an end-use was included in the other category (plug loads, process equipment, line losses, etc.). These data are shown in Figure 1.

Table 1 shows a summation of the typical yearly energy consumption for all facilities at Fort Drum. For each energy type, the yearly total is shown in units appropriate to the energy type and in a common unit as a basis for comparison. The total consumption values represent typical current yearly usage, from the best available data during 1990 and 1991. The yearly energy consumption was 1,600,903 MBtu.

Energy Resource Opportunities

After gaining a better understanding of the energy usage, the next step was to identify and evaluate the EROs at Fort Drum, provide the LCC analysis for each ERO, and prioritize the EROs based on their NPV. The NPV is defined as the difference between the LCC of the existing technology and that of the proposed alternative. Analysis results were presented in 14 common energy end-use categories (i.e., building lighting; streetlighting; HVAC system; refrigeration; boilers and furnaces; building envelope; high-temperature hot water (HTHW) systems; domestic hot water heating; fan, pump and compressor

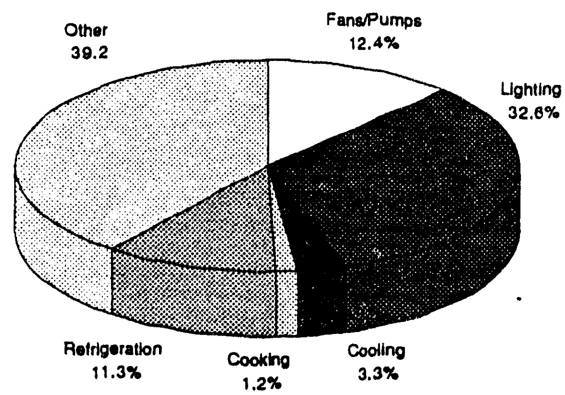

FIGURE 1. ENERGY USE BY END USE FOR ELECTRICITY (MBtu)

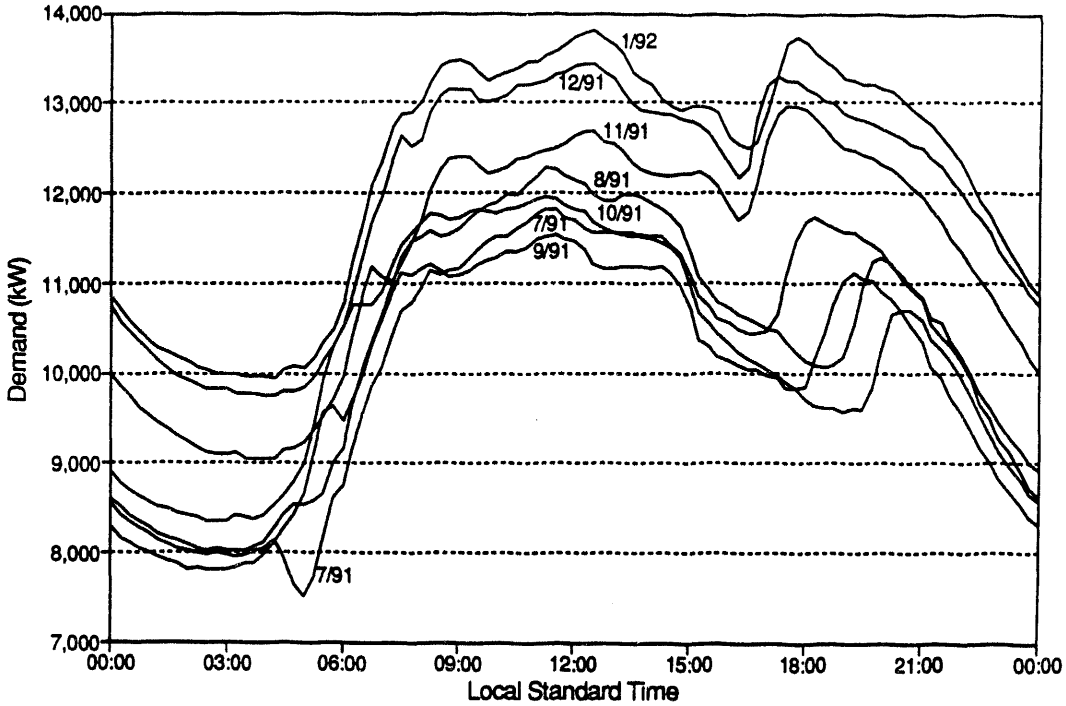

FIGURE 2. MONTHLY AVERAGE WEEKDAY DEMAND PROFILES AT FORT DRUM, NEW YORK (07/91 - 01/92)

TABLE 1. TYPICAL YEARLY ENERGY CONSUMPTION AT FORT DRUM

Energy Type	Yearly Total	Yearly Total [MBtu[a]]	Percent of Total Energy Consumption
Electricity	105,849 MWh	361,260[b]	22.6
Natural Gas	3,857 ktherm	385,720[c]	24.1
#2 Fuel Oil	2,407 kgallon	334,146[d]	20.9
Propane	652 kgallon	59,524[e]	3.7
HTHW	458,048 MBtu	458,048	28.6
Coal	98 Ton	2,205[f]	0.1
Totals:		1,600,903	100.0

(a) 1 MBtu = 1,000,000 Btu.
(b) 3,413 Btu/kWh.
(c) 100,000 Btu/therm; 1,050 Btu/ft^3 of natural gas.
(d) 0.1388 MBtu/gal of #2 fuel oil.
(e) 0.0913 MBtu/gal of propane.
(f) 22.5 MBtu/ton of coal.

motors; transmission and distribution; fuel-switching; electric demand reduction measures), and four building groups representative of Fort Drum: new post commercial, old post commercial, on-post family housing, and off-post family housing. Savings were indicated by fuel type: fuel oil #2, natural gas, propane, HTHW, and electricity.

After applying the analysis step described in the FEDS process section above, the following results were obtained (see Table 2). The present value of the installed cost of all cost-effective EROs at Fort Drum is over $16 million (1992 $). The present value of the savings associated with this investment is nearly $47 million (1992 $), for an overall NPV of approximately $31 million. By implementing all the cost-effective EROs, Fort Drum will reduce annual energy use by over 230,000 MBtu, or 15%. Annual energy expenditures will decrease by over $2.4 million, or a 20% reduction.

Table 3 provides a complete breakdown and summary of the electric EROs at Fort Drum.

The lighting ERO category has the greatest energy conservation 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.

A summary of the savings potential categorized by fossil fuel EROs is presented in Table 4.

The old post commercial buildings, consisting predominantly of World War II-era buildings heated with fuel oil, offers opportunities for fuel-switching to natural gas and replacement or conversion of aging and inefficient

TABLE 2. TOTAL SAVINGS, COST, AND NPV (1992 $)

Total Present Value of Installed Cost	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
$16,478,259	$34,018,474	$6,233,134	$6,621,546	$46,873,154	$30,644,466

TABLE 3. SUMMARY OF THE ELECTRIC EROS AT FORT DRUM

Energy Resource Opportunity Category	Present Value of Installed Cost[a] (1992 $)	Annual Energy Savings (kWh)	Value of Annual Energy Savings (1992 $)	Value of Annual Demand Savings (kW-mo)	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	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
Fluorescent	4,227,477	9,512,174	513,182	28,250	155,656	7,014,250
Incandescent	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	58,140	622,458	28,473	1,457	8,026	536,600
Motors	477,618	3,387,177	172,059	-1,907	-11,635	1,549,979
Peak-Shave	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.

TABLE 4. SUMMARY OF FOSSIL FUEL EROS AT FORT DRUM

Energy Resource Opportunity Category	Present Value of Installed Cost (1992 $)	Annual Energy Savings (MBtu)	Value of Annual Energy Savings (1992 $)	Total Net Present Value (1992 $)
Peak-Shave	194,000	-43,451	-216,000	1,362,873
CO_2 Sensors	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	3,821,989	60,513	318,136	1,757,340
Total	$7,872,607	139,161	$802,263	$10,567,266

(a) Analysis assumes no utility cost-sharing.

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 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 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.

Implementation Plan

The purpose of the FEDS process is to develop an analytical and rational approach to reducing the energy consumption (and energy cost) at Fort Drum. The implementation step of this process reviews the EROs, groups them into manageable projects, and develops a five-year energy management plan. When fully developed this plan would discuss the types of projects, timing, sources of funding, and other considerations for Fort Drum. In addition, a strategy for working with the electric and gas utility (Niagara Mohawk) would be part of this plan, in order to take full advantage of the utility incentives offered through demand-side management.

An implementation planning workshop was held with U.S. Army staff to develop a strategy for implementing the opportunities identified during the FEDS process. Resulting from the workshop were nearly 400 EROs divided into nine projects to be implemented over a three- to five-year period. Major projects to be initiated in the early years included:

- A fossil fuel project to provide natural gas for space heating and water heating on the old post; to enhance the FM control system on the old post; and to decommission, insulate, and provide package boilers for parts of the HTHW system on the new post. The space and water heating element converting fuel oil to natural gas use avoids emissions from fuel oil use and retrofit of aging storage facilities.
- An electric project to retrofit lighting on the new/old post, provide 2-speed motors for building ventilation

and sewer lift stations, replace and reconfigure streetlights throughout the Fort, and improve the site's power factor by installing capacitors, which corrects for the load's reactive component.

- A transportation project to convert portions of the existing vehicle fleet to compressed natural gas (CNG)-powered vehicles. Niagara Mohawk may pay for the refueling station, and government funding could be used to convert the vehicles.

- A maintenance project to reduce the HTHW supply temperature from the central steam plant. This project involves working with the contractor that operates the central steam plant to lower the supply temperatures to reduce the thermal losses from the distribution pipeline.

Other projects to be implemented in later years were also identified.

CONCLUSIONS

The federal energy manager needs a systematic process by which energy reduction can be achieved in a cost-effective manner. The FEDS process is designed to:

- conduct a fuel-blind analysis to identify all potential electric and fossil fuel energy efficiency, fuel switching, demand management, self-generation, improved operations and maintenance, energy purchase, etc., energy projects,

- evaluate the cost effectiveness of these projects based on the federally mandated life-cycle cost analysis procedures, and

- acquire all cost-effective energy projects at selected federal facilities through working with local utilities to fund, finance, and manage these activities.

This process is attractive to utilities to reduce DSM administrative costs by working with one large federal customer and benefit from a low-cost source of energy resources by avoiding large capital investment in new generating capacity. The federal customer will reduce energy costs and be able to verify how successfully statutory energy savings requirements are being met. At Fort Drum, the FEDS process is being successfully applied and the desired objective—to significantly reduce energy consumption at the Fort—is well on the way to being realized.

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