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# Tacoma Public Utilities

## Fort Lewis Electric Efficiency Retrofit

### Profile #71

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# Executive Summary

The Federal government is the largest single user of energy in the United States. In 1991 the government used about 1.5 quadrillion BTUs of energy, equal to approximately 2% of total U.S. energy consumption. Since estimates of potential energy savings from federally-controlled buildings and facilities range from 25-40%, the U.S. Department of Energy developed the Federal Energy Management Program (FEMP) which was supported by an executive order which called for a 5% reduction in 1985 levels of federal energy use and a 10% reduction in 1995 levels of energy use by the year 2000.

The Fort Lewis Electric Efficiency Retrofit program has sprung forth from this backdrop as one of the FEMP's flagship efforts. Largely carried out by the staff at Tacoma Public Utilities and at the Fort Lewis installation and supported by funding from the Bonneville Power Administration, this base-wide retrofit presents itself as a unique opportunity for significant U.S. taxpayer savings. Not only will a single utility customer provide large levels of savings, but a template has been developed for similar, subsequent, military retrofits.

Fort Lewis, Washington is essentially a small city "inhabited" by 25,000 permanent residents and 35,000 daytime residents. The "city" contains 4,450 buildings with a total floorspace of 23.9 million square feet. The majority of the total footage makes up barracks and offices; the balance of area is made up of a wide mix of uses including chapels, libraries, restaurants, hangers, and garages. By retrofitting the entire facility in discrete projects, electricity consumption is projected to be cut by 21% resulting in annual energy savings of 44,000 MWh.

Perhaps the most important aspect of the project is the cooperation that has been developed between a number of key players. Fort Lewis stands ready and willing to assure persistence of measures installed and will repay 15% of the cost of the entire retrofit over time. Tacoma Public Utilities is coordinating the project and is financing all the project's costs up-front but will be repaid by the Fort and through Bonneville Power Administration's Targeted Acquisition Program, resulting in a zero net project cost to Tacoma over time. Finally, the actual implementation is being conducted by an energy service company that will provide metered results for a subset of representative building types.

This profile presents the foundation for the Fort Lewis Electric Efficiency Retrofit project and its status. After several years of planning retrofits are now underway. To date four "energy conservation projects" involving 59 buildings are now complete. These four projects represent annual energy savings of 3,932 MWh (9% of the entire base's estimated savings) and costs of \$1,536,800, approximately 6% of the total planned retrofit cost at Fort Lewis.

## Fort Lewis Electric Efficiency Retrofit

Utility: Tacoma Public Utilities

Sector: Military installation

Measures: Primarily lighting applications; also motors and drives, HVAC controls, and distribution system upgrades

Mechanism: Financing agreement between TPU and Fort Lewis with 100% up-front costs paid by the utility and 15% repaid by the base. Verified energy savings bought by Bonneville Power from TPU. Measures installed in phases by an ESCo under contract to TPU

History: Two year planning process prior to implementation in 1993. Initiation of first four discrete projects covering 59 buildings in 1993

### 1993 Program Data

Annual energy savings: 3,932 MWh  
Lifecycle energy savings: 58,980 MWh  
Cost: \$1,536,800

### Conventions

For the entire 1993 profile series all dollar values have been adjusted to 1990 U.S. dollar levels unless otherwise specified. Inflation and exchange rates were derived from the U.S. Department of Labor's Consumer Price Index and the U.S. Federal Reserve's foreign exchange rates.

The Results Center uses three conventions for presenting program savings. **Annual savings** refer to the annualized value of increments of energy and capacity installed in a given year, or what might be best described as the first full-year effect of the measures installed in a given year. **Cumulative savings** represent the savings in a given year for all measures installed to date. **Lifecycle savings** are calculated by multiplying the annual savings by the assumed average measure lifetime. **Caution:** cumulative and lifecycle savings are theoretical values that usually represent only the technical measure lifetimes and are not adjusted for attrition unless specifically stated.

# Utility Overview

Tacoma Public Utilities (TPU) is a municipal utility consisting of an electricity provider (City Light), a water supplier (City Water), and a cargo handler (the Belt Line Railway). The utility was founded 100 years ago when the citizens of Tacoma voted to secure their future water and power resources by operating a combined water and power municipal utility. TPU was the first U.S. utility to deliver power for under 1 ¢/kWh and achieved this low rate as a result of harnessing hydroelectric power in 1912.

TPU serves the City of Tacoma and parts of Pierce County along the eastern coast of Puget Sound and south of Seattle in Washington. The nearby Green River is the City's primary water source and currently provides 72 million gallons per day. Other rivers in the area such as the Skokomish, Cowlitz, and Nisqually support hydroelectric projects to provide power for City Light. Tacoma has a diverse economic base founded in traditional Washington industries such as paper and lumber, but includes other industrial concerns like chemical companies and food processing.

TPU served an average of 132,400 electric customers and 76,700 water customers during 1992.[R#1] City Light's customers included 120,400 residential customers, 2,000 industrial customers, and 10,000 commercial customers.[R#12]

A severe drought reduced both electricity and water sales during 1992 down to 6.2 million MWh and 3,100 million cubic feet of water from 6.6 million MWh and 3,460 million cubic feet in 1991.[R#1] Power sales were divided between residential customers at 32% and commercial and industrial users at 68%.[R#12]

Despite rate increases during 1992 of 4.4% and 4.0% for City Light and City Water, respectively, rates remain low compared to the rest of the country as the accompanying table shows. However, 1992 revenues decreased from 1991 levels as a result of the drought. City Light operating revenues were \$178.6 million in 1992 as compared

<b>TPU-CITY LIGHT 1992 STATISTICS</b>	
Number of Electric Customers	132,000
Energy Sales	6,200 GWh
Electric Revenue	\$178.6 million
Winter Peak Demand	1,209 MW
Summer Peak Demand	736 MW
Generating Capacity	871 MW
<b>Average Electric Rates</b>	
Small Commercial	3.93 ¢/kWh
Residential	3.86 ¢/kWh
Commercial/Industrial	2.98 ¢/kWh
Military	2.42 ¢/kWh
Large C/I Interruptible	2.13 ¢/kWh

to \$184.9 million in 1991 and City Water showed a roughly equivalent drop off in revenues from \$22.7 million in 1991 to \$21.6 million in 1992.[R#1,14]

Tacoma Public Utilities gets the bulk of its power from hydroelectric generation. The utility owns six major hydro plants and is currently building a seventh, the Wynoochee River plant, using an existing dam to minimize environmental impact. The utility also owns a coal-fired steam generating plant and has part ownership in the Centralia coal-fired steam plant giving it a total generating capacity of 871 MW. Winter peak demand for the utility is 1,209 MW. The remainder of TPU's power needs are purchased under contract with the Bonneville Power Administration (BPA).[R#1,12] ■

# Utility DSM Overview

<b>DSM Overview</b>	<b>TPU DSM Expenditure (x1000)</b>	<b>BPA DSM Contribution (x1000)</b>	<b>Total Annual DSM Expenditure (x1000)</b>	<b>Annual Energy Savings (MWh)</b>
1990	\$476	\$2,003	\$2,479	1,389
1991	\$770	\$1,242	\$2,011	31,891
1992	\$4,024	\$5,057	\$9,081	31,796
<b>Total</b>	<b>\$5,270</b>	<b>\$8,302</b>	<b>\$13,572</b>	<b>65,076</b>

Resource conservation efforts have been underway at TPU since 1980. In addition to conservation and efficiency programs for both electricity and water TPU has been aggressively pursuing conservation in other areas such as timberland, wetlands, and fish and game. For example, the Cowlitz wildlife area surrounding City Light's two Cowlitz hydroelectric projects was tripled during 1992 under a \$14 million agreement with the U.S. Fish and Wildlife Department in which City Light agreed to purchase 6,900 acres of timberland and fund the acquisition of \$3 million worth of wetlands. [R#1]

City Water strongly emphasized water conservation during 1992 in response to the Northwest regional drought. By June of that year the utility had set a goal of using 20% less water to meet its goal of reducing overall water use to less than 81 million gallons per day. The utility's largest customer, Simpson Tacoma Kraft, was instrumental in City Water's plans, reducing its use by an impressive 10 million gallons per day. In addition the utility distributed nearly 4,000 low-flow showerheads, faucet aerators, and toilet fixtures to reduce residential consumption of both water and electricity. The Energy Conservation Office also took a significant step to institutionalize conservation by hiring its first staff water conservationist. [R#1,12]

City Light initiated demand-side management programs in 1980 largely in response to the passage of the Pacific Northwest Electric Power Planning & Conservation Act. This mandate also governs conservation activities at Bonneville Power Administration (BPA) which is the major

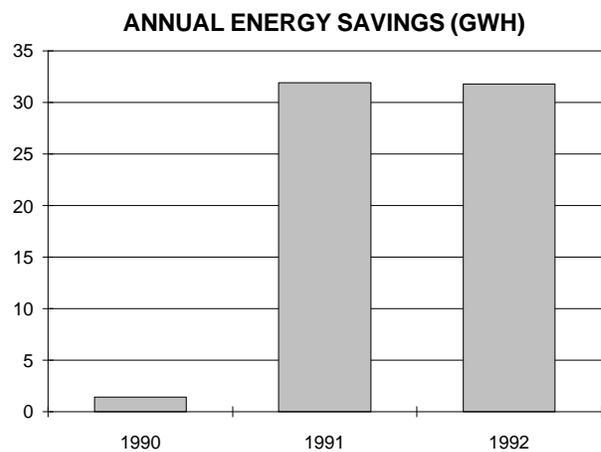
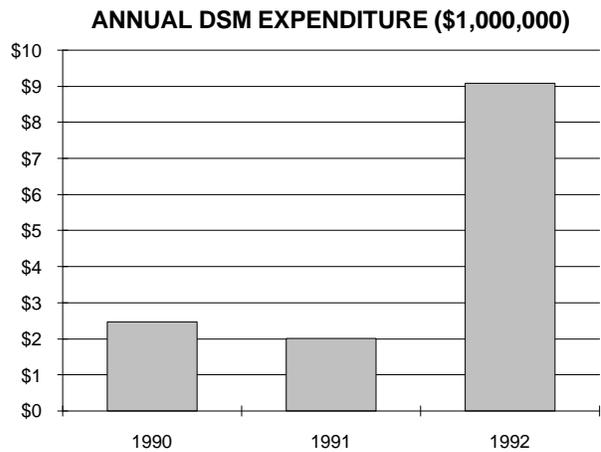
federal power marketing agency in the area. Due to this mandate BPA shares a significant percentage of the costs associated with TPU's DSM activities. TPU ran primarily residential programs until 1988-1989 when it began to expand its efforts significantly.

<b>TPU CURRENT DSM PROGRAMS</b>
<b><u>Residential Retrofit</u></b>
Non-Low Income Weatherization
Low Income Weatherization
Zero Interest Loan
Energy Efficient Showerheads
Water Heater Rebates
Multifamily Loan
<b><u>Energy Information &amp; New Construction</u></b>
Model Conservation Standards
Super Good Cents Home & Appliances
<b><u>Commercial &amp; Industrial</u></b>
Energy Smart Design
Energy Savings Plan
<b>Fort Lewis Electric Efficiency Project</b>
Commercial Loan
Major Plants Study

The utility focuses most efforts at achieving energy savings as it has less need for capacity reductions given its strong hydro resource base. Thirteen DSM programs are currently implemented by the Energy Conservation Section within City Light in three primary areas: Residential Retrofit, Energy Information & New Construction, and Commercial/Industrial. These programs allowed TPU to save 3.56 MW and 31,796 MWh in 1992. In 1992, the utility spent \$4,024,300 on its demand-side management programs or the equivalent of 2.3% of City Light gross revenue. When BPA's contribution of \$5,057,000 is added to the net DSM cost to TPU the utility spent \$9,081,000 on DSM, or 5.1% of City Light's gross revenue. [R#2]

The most aggressive residential program in 1992 involved the distribution of 7,494 low-flow, high-performance showerheads to TPU customers, which provided both energy savings and water conservation to the utility. The program's success has led TPU to expand its efforts by providing direct installation service in 1993. This service is expected to result in the installation of 50,000, 2.5 gallon/minute showerheads for single-family and multi-family customers. [R#2]

The most ambitious DSM program at TPU is in fact the largest single energy conservation project ever undertaken in the Pacific Northwest and the subject of this profile. In a unique partnership between City Light, BPA, EUA/Onsite, L.P. (an energy services company), and the U.S. Army's Fort Lewis, the base's 4,450 buildings have been targeted to save 44 million kWh through expenditures up to \$35 million over five years. These projected electric energy savings represent over 20% of Ft. Lewis' current consumption or enough to power 2,900 Tacoma homes. [R#1] ■



# Program Overview

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The tale of the Fort Lewis electric efficiency retrofit from conceptualization to implementation begins with the Federal government's mandate to conserve energy and has progressed to the implementation of one of the most focused electrical conservation retrofits in this country by Tacoma Public Utilities and its partners.

## THE FEDERAL ENERGY MANAGEMENT PROGRAM

The Federal government is the largest single user of energy in the United States and consumes roughly 1.5 quadrillion BTUs at a total cost of about \$10 billion annually. By comparison, total U.S. energy consumption in 1991 was 81 quads. One-third of the government's energy consumption (0.5 quads) and half of its energy bill (\$5 billion) is in buildings and facilities. Of this cost, fully two-thirds is for electricity. Estimates of the economically available financial and energy savings in Federal buildings range from 25-40% or more. [R#6] Against this backdrop of massive consumption the Federal government has mandated energy efficiency targets of 5% of 1985 use by 1995 and an additional 10% by the year 2000. [R#7]

Two key barriers to improving the energy efficiency of Federal facilities have been identified. The first is access to capital as constrained budgets and regulations on budget expenditures often preclude investment in efficiency. The second barrier relates to Federal procurement and contracting regulations that require competitive procurement, effectively delaying energy efficiency retrofit implementation. [R#5,6]

To overcome these barriers the U.S. Department of Energy's (DOE) Federal Energy Management Program (FEMP) has designed a model program intended to be attractive to both utilities and Federal facilities while providing substantial energy and financial savings. [R#5,6] The three key components of this program are: 1. A fuel-neutral assessment of the energy efficiency potential of a facility. 2. A sole-source agreement between the facility and the utility including provisions for the utility to competitively procure an energy services company (ESCO) to perform audits and implement projects (or to fulfill that role itself), and provide 100% up front financing for project activities. 3. Significant cost-sharing between the utility and the facility of the installed costs of efficiency measures.

The fuel-neutral assessment is done to quantify the magnitude of the potential efficiency resource. The Federal government faces lifecycle costing requirements for equip-

ment purchases that must be met and often fuel-switching is a least-cost strategy. [R#5,6] However, as in the case of Ft. Lewis where City Light does not fund fuel-switching measures, this does not require utility funding of fuel-switching.

The ESCo procurement (or the utility's ability to implement energy saving measures) and up-front financing provisions directly address the two critical barriers identified above.

The cost-sharing arrangement targets the total installed cost of the project rather than the total value of the energy savings through a more conventional share-savings arrangement. This somewhat unusual method of sharing costs allows the facility to repay the utility in a timely and accurate fashion through the energy savings. This arrangement requires that all parties agree on the technologies to be implemented and the installed costs of these technologies. Such an arrangement also allows the cost-sharing to vary between utilities and within a utility, according to the reliability of the installed technology and with the utility's demand for efficiency resources. [R#6]

## IDENTIFYING A PROJECT AND PARTICIPANTS

Having the basic components of a model program in place, FEMP began the search for a pilot project in 1991. The Pacific Northwest was viewed as an attractive market for several reasons. First, a number of utilities in the region were already implementing demand-side management programs. These utilities had demonstrated the expertise and commitment to DSM as resource that FEMP believed would be necessary for a successful pilot project.

Second, both Pacific Northwest Laboratory (PNL), FEMP's lead laboratory, and the Bonneville Power Administration are located in the area providing a strong resource base for any effort. In fact, PNL had developed a working relationship with several military installations as a result of an agreement between FEMP and the U.S. Army Forces Command (FORSCOM). Fort Lewis, a FORSCOM facility, was actively involved in conservation activities at the time and expressed willingness to participate in a comprehensive program.

BPA was promoting conservation in its service territory as part of its mandate under the Pacific Northwest Electric Power Planning & Conservation Act of 1980. Further, BPA's Targeted Acquisition Program allows a utility that purchases

power from BPA to identify and secure electric efficiency resources from its own customers and then to sell those resources back to Bonneville for use elsewhere.[R#5]

To maximize transferability of the program and to take advantage of the Targeted Acquisition Program, FEMP, PNL, and BPA agreed that the target facility should not be a direct customer of BPA, but a customer of a utility that is served by Bonneville.[R#5] Tacoma Public Utilities, with its history of conservation, fit the profile of a candidate utility.

TPU was approached by the Federal agencies to determine its interest in participating. The utility was aggressively seeking energy savings from conservation and the opportunity to gather large savings from a single source was attractive. TPU was further interested in the use of an energy services company, a mechanism that the utility had not explored in its other DSM programs. The ability to assist one of its largest customers to meet their needs convinced TPU to participate, and the project's foundation was complete.[R#13]

#### **THE FORT LEWIS ELECTRIC EFFICIENCY RETROFIT**

TPU has targeted total savings from the project of 44,000 MWh. These savings would be 21% of current energy consumption or roughly equivalent to the power required for 2,900 residences in Tacoma. To illustrate the magnitude of this project, the total expected savings outweigh the savings from all of TPU's 1992 DSM programs combined.

To secure the savings a multi-phase program was designed. Each phase, or what is called an energy conservation project (ECP), includes the installation of energy conservation measures (ECMs) in a variety of building types at the fort. This approach was chosen to allow the pace of the project to be managed carefully and the lessons learned in early installations to be incorporated into the remaining ECPs. This approach also avoids the need to audit and develop proposals for all buildings up front. The total retrofit is expected to take five years.[R#3,4,8]

TPU is paying 100% of the up front costs of the retrofit. Fort Lewis will repay 15% of these costs upon completion of installation. Tacoma Public Utilities expects to recoup the remainder of its expenses by selling the energy saved at Fort Lewis to BPA at a cost of 3.3 ¢/kWh under BPA's Targeted Acquisition Program, thus making the program revenue-neutral for the utility.

City Light also arranged the procurement of an energy services contractor by administering a competitive bidding process. As a result of that process EUA/Onsite, L.P. was selected by a team consisting of representatives from the utility, FEMP, PNL, the Washington State Energy Office, and Snohomish Public Utility District to provide energy services to Ft. Lewis under contract to City Light. ■

#### **FORT LEWIS**

Naturally before FEMP and its utility allies would invest time and effort into a flagship project, all parties involved wanted some assurance that the base would not be slated for closure! Fort Lewis is now the only major U.S. Army installation on the West Coast not scheduled for closure. In fact the base is expected to expand by absorbing personnel from other sites including an infantry division from Fort Ord in southern California.[R#9]

Fort Lewis maintains its own electrical distribution system with City Light providing power to only three major substations. Despite an extensive district heating system fueled by oil and natural gas, the base is City Light's fifth largest electric customer. Annual energy use totals 2.5 trillion BTU, with annual electric consumption of 195,000 MWh or roughly 26% of the total energy usage. Fort Lewis operates on a base load of 15,000 - 17,000 kW with a peak demand of 27,000 kW before noon. Annual costs for energy are over \$12 million with \$4.5 million spent on electricity alone.[R#5,9]

The base has 4,450 buildings with total floorspace of 23.9 million square feet of which 57% is barracks and office space. The remaining space encompasses a range of uses typically found in a small city of equal size, including libraries, chapels, restaurants, and garages. Roughly 25,000 permanent and 35,000 daytime residents occupy Fort Lewis.[R#5,9]

PNL conducted a preliminary assessment of the technical potential for savings at Fort Lewis. Savings of slightly more than 43,000 MWh were identified at a cost of less than 3.7 ¢/kWh in PNL's initial assessment.[R#5] This estimate has been slightly modified by City Light resulting in targeted annual energy savings of 44,000 MWh.

# Implementation

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Formal contracts were negotiated to delineate responsibilities and finalize project commitments once the project participants had agreed to the project in principle. The first contract was signed in May, 1992 between TPU and Fort Lewis incorporating the financing, cost-sharing, and energy service company procurement provisions.

With the initial contract in place TPU focused its attention on securing an agreement with BPA to return energy savings from Fort Lewis for money under the Targeted Acquisition Program. A contract between BPA and TPU was signed incorporating provisions for BPA to buy the verified energy savings resulting from the retrofit from TPU at the rate of 3.3¢/kWh over a ten-year period.

TPU also implemented a two-part selection process for an energy services company. First TPU issued a Request For Qualifications (RFQ) to identify potential interested and qualified ESCos. In response, three qualified firms were selected by the Selection Advisory Committee mentioned in the previous section. These firms were then invited to respond to a Request for Proposal (RFP) that was issued on April 1, 1992. EUA/Onsite, L.P. was announced as the winning firm on July 8, 1992 and a contract for the delivery of 44,000 MWh over a three-year period with two, one-year extension options was signed between the ESCo and the utility on December 16, 1992. [R#4]

The project has been structured in distinct phases. The initial phase included a sample of seven representative buildings selected to pilot test the process and measures used in the retrofit. To date four distinct energy conservation projects (ECPs) have been initiated covering 59 diverse buildings including barracks, a dining hall, aircraft hangers, a dental clinic, restaurants, and a chapel. [R#8]

In each energy conservation project EUA/Onsite and its subcontractors install measures according to a specific plan that includes number of measures, costs, and an installation schedule. The plans for each ECP are approved by both the utility and the base.

## MEASURES INSTALLED

Due to the nature of the financing agreement the utility, Fort Lewis, and the ESCo had to agree to the type and number of measures to be installed at the base. [R#9] The early ECPs have primarily targeted lighting applications given that the retrofit is limited to electric efficiency and much of the base is heated by oil or natural gas. Lighting measures installed include new fluorescent fixtures, retrofits of incandescent lighting with T8 retrofits, reflectors and electronic ballasts, compact fluorescent lamps, and lighting controls. A strong emphasis has been placed on installing whole fixtures in light of the desire to maintain savings. [R#8]

Additionally, other measures such as electronic time clocks, motor replacements, variable speed drives, and HVAC controls were installed in the first four ECPs. [R#8] Subsequent ECPs are expected to include similar measures.

## STAFFING REQUIREMENTS

In a project of this magnitude and scope the commitment of the people involved cannot be underestimated. At Tacoma Public Utilities, Jake Fey, the head of City Light's Conservation programs was instrumental in selling the program within the utility. Dalene Moore and Peter Meyer of the Commercial/Industrial unit designed the program, wrote and administered the ESCo selection process, and headed the contract negotiations with Fort Lewis, the ESCo, and BPA. Jon Paxton is the Project Manager for implementation. Finally, Joe Taffe, Verification Coordinator, is in charge of the verification component of the project. [R#12]

EUA/Onsite has a team of 5 people working full time to implement the retrofits on the base. They work in conjunction with Fort Lewis' facilities management group, headed by Newell Flood, Chief of Operations & Maintenance Division and consisting of a mechanical engineer, an electrical engineer, and an installation inspector as needed. Additionally, EUA/Onsite's electrical subcontractor employs between 8 and 12 full-time electricians on site, with plans to expand as the project gears up. [R#12] ■

# Monitoring and Evaluation

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## MONITORING

The initial energy conservation project (ECP) of the Fort Lewis project was explicitly designed to include a thorough monitoring component. In fact, each ECP includes specifications for verification strategies and the costs of this verification. A typical verification plan includes daily inspection reports, milestone progress charts, a set level of inspection for each type of measure (i.e., the sample size of measures to be inspected), a log of inspection requests from other project partners, and list of all required action and follow-up items. [R#9]

Utility and base personnel verify the installation of measures by the ESCo by performing site inspections behind the ESCo's installation teams. Inspection staff are on site on a daily basis at random times. During an installation check, TPU staff check for equipment performance while staff from Fort Lewis help ensure that the actual physical installation meets Federal requirements. EUA/Onsite has designed a rigorous quality control process in an attempt to ensure that all installations will meet the inspection standards. [R#9]

It should be noted that payment to EUA/Onsite is based on the successful installation of measures during each ECP. Eighty-five percent of the bid price is paid to the ESCo upon inspection by the utility and the base. The remaining 15% is paid upon verification of the savings as described below, provided actual savings are within 15% of projected targets. If savings exceed projections by more than 15% the ESCo pays a penalty to City Light of 5%. If savings fall below 15% of projections the ESCo forfeits the final 15% payment. [R#8,12]

Once equipment has been installed it is the property of Fort Lewis, however EUA/Onsite is obligated to ensure that it performs during the initial warranty period of one year and remedy any failures. Fort Lewis is responsible for maintaining the installed measures or replacing them with comparable equipment for a ten-year period. TPU has made provisions to monitor the installations itself during this period and will make more detailed inspections of specific types of equipment should cause arise. [R#9]

If Fort Lewis fails to keep the measures in place TPU can collect the financial value of the savings from the time of removal or failure until the end of the 10-year period from the Fort. This also requires TPU to adjust its billing of BPA for energy savings accordingly. [R#9,12]

## EVALUATION

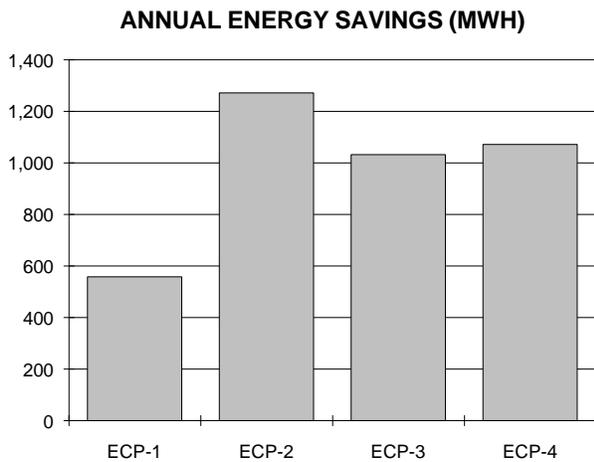
The Fort Lewis project is particularly noteworthy as the energy savings data is based on a subset of metered results. Each ECP will be verified according to its verification plan that includes both a check of the installation as well as an evaluation of the savings through an extrapolation from a sub-set of metered technologies. Individual verification plans include slightly different components based on the number and types of buildings retrofitted and measures installed. However, much of the verification methodology is standard for major end-uses such as lighting, motors, and HVAC applications.

First, a pre-installation check of energy consumption is performed. For lighting this check is performed by measuring volts and amps on a room-by-room basis by selecting rooms with the greatest number of fixtures and extrapolating to the remaining areas to meet the basic one-in-thirty metering requirement. For mechanical equipment a random sample of the equipment is metered to develop a pre-retrofit consumption baseline. Operational hours are also noted to account for efficiency gains from controls. [R#10]

Post-installation metering is done in the same fashion. Typically short-term metering is performed over a two-week period. Operational hours are noted through the use of run-time-loggers. These loggers may be used for up to 90 days to determine the persistence of savings. [R#10] As noted above, City Light intends to perform further verifications over the next ten years to monitor persistence. ■

# Program Savings

<b>Savings Overview</b>	<i>Annual Energy Savings (MWh)</i>	<i>Lifecycle Energy Savings (MWh)</i>
ECP-1	557	8,355
ECP-2	1,272	19,080
ECP-3	1,032	15,480
ECP-4	1,071	16,065
1993 Total	3,932	58,980

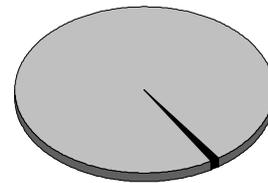


The retrofit of Fort Lewis has resulted in estimated annual energy savings of 3,932 MWh to date. All energy savings occurred in 1993 which is the first year of project implementation. These savings represent roughly nine percent of the projected total and have been gathered in increments ranging from 557 MWh in ECP-1 to 1,272 MWh in ECP-2. There are no capacity savings calculated from the project as it is focused entirely on securing energy conservation. [R#8]

## PARTICIPATION RATES

Each ECP has been structured to include a discrete number of buildings. The first four phases have retrofitted 7, 18, 15, and 19 buildings respectively for a total of 59. [R#8] There are approximately 4,450 buildings at Fort Lewis. Thus the savings gained to date are large relative to the number of buildings that have been addressed. Average savings per building have been 66,667 kWh. Energy savings have ranged from a high of 79,576 kWh per building in ECP-1 to 56,406 kWh in ECP-4.

*Buildings Unretrofitted*  
99%



*Buildings Retrofitted*  
1%

<b>Participation</b>	<i>Buildings</i>	<i>Annual Energy Savings per Building (kWh)</i>
ECP-1	7	79,576
ECP-2	18	70,682
ECP-3	15	68,823
ECP-4	19	56,406
1993 Total	59	

## SAVINGS ADJUSTMENTS

TPU does not feel any adjustments to savings estimates are necessary for a number of reasons. First, given that the savings from each phase are calculated by measurement at the end-use level and include monitored operational pat-

tems the utility believes the data to be an accurate reflection of the actual energy improvements to the facilities. Second, the nature of the project mitigates such traditional factors influencing savings levels such as free ridership by other participants. Finally, the high knowledge level of the customer and the manner in which the base operates suggest that these savings will be quite persistent, a factor all parties have acknowledged through the use of a penalty provision for failure to maintain the measures.

## MEASURE LIFETIME

TPU is using an average measure lifetime of 20 years for the measures installed in each ECP. The utility believes this measure life is supported by the facility control exerted on Fort Lewis as well as the age and existing condition of the base's equipment. [R#9] Additionally, the penalty provisions in place for the project's first ten years (described in the Monitoring & Evaluation Section) offer security to the utility beyond that of ordinary commercial demand-side management efforts.

The utility has also developed a comprehensive schedule of measure lifetimes for use in determining cost-effectiveness of individual measures and structuring the repayments under the financing agreement with the base. See the attached chart for lighting, controls, and motors and drives measures.

For the purposes of calculating lifecycle energy savings and the cost of saved energy, which assumes a technical measure life amortization period, The Results Center has applied a 15 year average measure lifetime to the retrofits taking place at Fort Lewis.

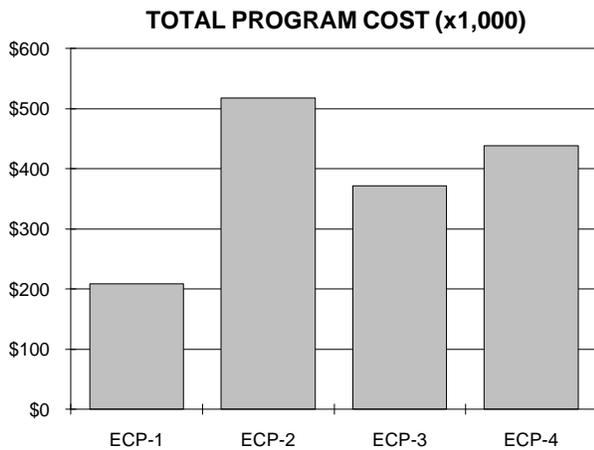
## PROJECTED SAVINGS

The entire Fort Lewis project has a goal of 44,000 MWh of annual energy savings. Assuming a 15 year life, the measures installed will yield lifecycle savings of 669,000 MWh. The Results Center calculates lifecycle savings using a 15 year measure lifetime for the first four ECPs to be 59,000 MWh or 9% of projected savings. ■

<b>INSTALLED MEASURE LIFETIMES</b>	
<b>Lighting</b>	
Modular Compact Fluorescent Lamp	12
Integral Compact Fluorescent Lamp	2
Metal Halide Lamp	3
Low Pressure Sodium	5
High Pressure Sodium	5
Energy Efficient Fluorescent Lamp	5
Efficient Ballast	12
Electronic Ballast	12
Efficient Fixture	20
Dimming Systems	20
On-Off Switching	7
Motion Sensor	10
<b>Controls</b>	
Computer Logic EMS	13
Deadband Thermostat	13
Time Clocks	10
Electric Controls	16
Electronic Controls	15
Pneumatic Controls	20
<b>Motors and Drives</b>	
Standard Electric Motor	15
High Efficiency Motor	17
Variable Speed DC Motor	18
Solid State VSD	15
Belt Type VSD	10
Motor Starters	17

# Cost of the Program

<b>Costs Overview</b>	<i>Administration (x1000)</i>	<i>Verification (x1000)</i>	<i>Measure Cost (x1000)</i>	<i>Total Program Cost (x1000)</i>	<i>Cost per Building</i>
ECP-1	\$11.4	\$10.6	\$187.1	\$209.1	\$29,872.66
ECP-2	\$27.4	\$26.2	\$464.0	\$517.7	\$28,761.55
ECP-3	\$19.7	\$18.8	\$333.1	\$371.6	\$24,773.12
ECP-4	\$23.2	\$22.2	\$392.9	\$438.4	\$23,071.85
1993 Total	\$81.7	\$77.9	\$1,377.2	\$1,536.8	



**Data Alert:** 1993 expenditures have been leveled to 1990 dollars using a 1992 conversion factor since the 1993 factor is not yet available. The administration and verification costs assigned to TPU have been calculated using a ratio of total projected costs as described in the cost component section. The costs presented represent the first of four retrofit projects only, approximately 6% of the total planned retrofit activity in terms of expenditures at Fort Lewis.

<b>Cost of Saved Energy (¢/kWh)</b>	<i>Discount Rates</i>						
	3%	4%	5%	6%	7%	8%	9%
ECP-1	3.14	3.38	3.62	3.87	4.12	4.39	4.66
ECP-2	3.41	3.66	3.92	4.19	4.47	4.75	5.05
ECP-3	3.02	3.24	3.47	3.71	3.95	4.21	4.47
ECP-4	3.43	3.68	3.94	4.21	4.49	4.78	5.07

The estimated total cost of the project to date is \$1,536,800. This cost includes installation costs paid to the ESCo as well as estimated administration and verification costs to City Light. [R#8] While the utility must bear the full up-front costs, BPA is responsible for repayment under the Targeted Acquisition Program at the rate of 3.3 ¢/kWh. TPU has recently invoiced BPA for the first payment under this arrangement. Fort Lewis will also repay the utility its 15% commitment but has not begun to make repayments to date. The project is designed to be revenue neutral for City Light. [R#12]

### COST EFFECTIVENESS

The Fort Lewis retrofit must meet levelized lifecycle cost requirements imposed by both City Light and the Federal government. The utility requires each ECP implemented in 1993 to have a levelized cost below 42.6 mills/kWh, or 4.26¢/kWh (10 mills = 1¢) in 1992 dollars. However, individual measures may cost as much as 60 mills/kWh under BPA regulations that TPU is using. [R#8] For project phases in years after 1993 a similar cost-effectiveness benchmark will be established by updating the levelized cost.

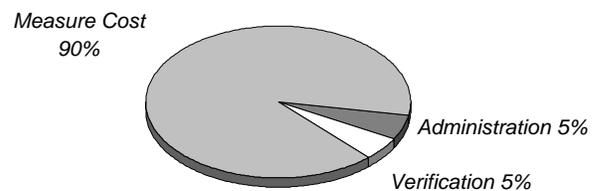
The Results Center has calculated the total cost of saved energy for the project in 1993 to range from 3.47 ¢/kWh for phase 3 to a high of 3.94 ¢/kWh in phase 4 at a five percent real discount rate using a 15 year measure lifetime. City Light notes that the project can and will be fine-tuned to keep it revenue neutral as it is implemented. If costs begin to outweigh repayments, cost-effectiveness can be tightened. Conversely, if expenditures are below revenues the cost-effective threshold can be relaxed to allow more costly measures to be implemented. [R#12] Note again that the ultimate cost to TPU will be zero, that the cost to the Fort will be 15% of the total project cost, and that BPA pays the lion's share of the total retrofit costs.

### COST PER PARTICIPANT

The project had an average cost of \$26,608 per building in its first four phases. Costs have ranged from a high of \$29,873 per building for ECP-1 where seven buildings were retrofitted down to \$23,072 in ECP-4 to improve 19 buildings.

### COST COMPONENTS

The bulk of 1993 costs were for the installation of efficiency measures including equipment and installation costs. These costs totalled \$1,377,200 and represented 90% of total project costs. Other costs included City Light administration and verification expenses. The Results Center calculated these costs by pro-rating the projected administrative and verification costs during the implementation phase of the entire project. The calculation compared the ratio of administrative, verification, and installation costs using the projected administrative and verification costs and the actual implementation costs of the first four ECPs. Estimated costs were nearly equally divided at 5% each between utility administrative costs of \$81,700 and project verification costs of \$77,900. [R#8,11]



The utility has projected total installation costs to reach \$24,600,000 over the five years of implementation. Administrative costs of \$1,453,592 and verification costs of an additional \$1,391,500 make projected total costs during the installation phase \$27,445,092. TPU has budgeted an additional \$275,000 during 1998 and 1999 for administration of the project. Verification is scheduled to continue until the year 2008 at annual costs ranging from \$283,000 in 1998 down to \$24,000 in 2005, resulting in total verification costs of \$780,000 after installation is complete. [R#11] Thus total project costs would be slightly over \$29 million in 1993 dollars. ■

# Environmental Benefit Statement

**AVOIDED EMISSIONS: Based on 3,932,000 kWh saved 1993**

Marginal Power Plant	Heat Rate BTU/kWh	% Sulfur in Fuel	CO2 (lbs)	SO2 (lbs)	NOx (lbs)	TSP* (lbs)
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**Coal Uncontrolled Emissions**

A	9,400	2.50%	8,477,000	201,000	41,000	4,000
B	10,000	1.20%	9,040,000	78,000	26,000	19,000

**Controlled Emissions**

A	9,400	2.50%	8,477,000	20,000	41,000	0
B	10,000	1.20%	9,040,000	8,000	26,000	1,000
C	10,000		9,040,000	52,000	26,000	1,000

**Atmospheric Fluidized Bed Combustion**

A	10,000	1.10%	9,040,000	24,000	13,000	6,000
B	9,400	2.50%	8,477,000	20,000	16,000	1,000

**Integrated Gasification Combined Cycle**

A	10,000	0.45%	9,040,000	16,000	3,000	6,000
B	9,010		8,131,000	6,000	2,000	0

**Gas Steam**

A	10,400		4,931,000	0	11,000	0
B	9,224		4,282,000	0	27,000	1,000

**Combined Cycle**

1. Existing	9,000		4,282,000	0	16,000	0
2. NSPS*	9,000		4,282,000	0	8,000	0
3. BACT*	9,000		4,282,000	0	1,000	0

**Oil Steam--#6 Oil**

A	9,840	2.00%	7,137,000	108,000	13,000	12,000
B	10,400	2.20%	7,569,000	107,000	16,000	8,000
C	10,400	1.00%	7,569,000	15,000	13,000	4,000
D	10,400	0.50%	7,569,000	45,000	16,000	2,000

**Combustion Turbine**

#2 Diesel	13,600	0.30%	9,472,000	19,000	29,000	2,000
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**Refuse Derived Fuel**

Conventional	15,000	0.20%	11,246,000	29,000	38,000	8,000
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In addition to the traditional costs and benefits there are several hidden environmental costs of electricity use that are incurred when one considers the whole system of electrical generation from the mine-mouth to the wall outlet. These costs, which to date have been considered externalities, are real and have profound long term effects and are borne by society as a whole. Some environmental costs are beginning to be factored into utility resource planning. Because energy efficiency programs present the opportunity for utilities to avoid environmental damages, environmental considerations can be considered a benefit in addition to the direct dollar savings to customers from reduced electricity use.

The environmental benefits of energy efficiency programs can include avoided pollution of the air, the land, and the water. Because of immediate concerns about urban air quality, acid deposition, and global warming, the first step in calculating the environmental benefit of a particular DSM program focuses on avoided air pollution. Within this domain we have limited our presentation to the emission of carbon dioxide, sulfur dioxide, nitrous oxides, and particulates. (Dollar values for environmental benefits are not presented given the variety of values currently being used in various states.)

## HOW TO USE THE TABLE

1. The purpose of the accompanying page is to allow any user of this profile to apply Tacoma Public Utilities' level of avoided emissions saved through its Fort Lewis Electric Efficiency Retrofit to a particular situation. Simply move down the left-hand column to your marginal power plant type, and then read across the page to determine the values for avoided emissions that you will accrue should you implement this DSM program. Note that several generic power plants (labelled A, B, C,...) are presented which reflect differences in heat rate and fuel sulfur content.

### \* Acronyms used in the table

TSP = Total Suspended Particulates

NSPS = New Source Performance Standards

BACT = Best Available Control Technology

2. All of the values for avoided emissions presented in both tables include a 10% credit for DSM savings to reflect the avoided transmission and distribution losses associated with supply-side resources.

3. Various forms of power generation create specific pollutants. Coal-fired generation, for example, creates bottom ash (a solid waste issue) and methane, while garbage-burning plants release toxic airborne emissions including dioxin and furans and solid wastes which contain an array of heavy metals. We recommend that when calculating the environmental benefit for a particular program that credit is taken for the air pollutants listed below, plus air pollutants unique to a form of marginal generation, plus key land and water pollutants for a particular form of marginal power generation.

4. All the values presented represent approximations and were drawn largely from "The Environmental Costs of Electricity" (Ottinger et al, Oceana Publications, 1990). The coefficients used in the formulas that determine the values in the tables presented are drawn from a variety of government and independent sources. ■

# Lessons Learned / Transferability

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## LESSONS LEARNED

The first two phases of implementing the Fort Lewis retrofit have produced significant energy savings at a low cost to all the partners involved. TPU believes that this success will continue throughout the remainder of the project as the participants have a better understanding of the implementation process. The project's pace is expected to increase as both the ESCo and the utility refine their implementation and verification mechanisms.

By far the bulk of the learning in this project came in its planning stages. The number of participants and the complexity of the contractual arrangements between these organizations required an unwavering commitment by the individuals involved just to make the project a reality. Participants have made adjustments to accommodate their respective schedules while still completing an agreement that provides strong guarantees for persistent savings at cost-effective levels.

The ability to cost-share with Fort Lewis and to sell the savings to Bonneville are important components of the project as they allow City Light to leverage limited resources. Both Fort Lewis and BPA also benefit from cost sharing. Their expenses further ensure a strong commitment to the project as they become stakeholders in its success.

To implement the project the utility has employed an energy services company. This arrangement allows TPU to focus its efforts on project oversight and verification of savings rather than day-to-day administration and installation of efficiency measures. These tasks require considerable

time and effort for a project of this magnitude and could potentially drain project resources.

## TRANSFERABILITY

The Tacoma Public Utilities project at Fort Lewis is a highly specific implementation of a model program designed for Federal facilities. The two central features of the model program are up-front financing and the ability to install energy saving measures through a contract with a third-party or directly by the sponsoring utility. This design has been chosen specifically to facilitate implementation at military sites throughout the country.

City Light notes that this model may well be applicable to other multi-building sites under single ownership. Such potential candidates include universities, corporate complexes, and local government facilities.[R#12]

The Fort Lewis retrofit is focused only on electric efficiency but military facilities in general offer substantial opportunities for gas and electric, even gasoline and diesel savings, and therefore these facilities can be particularly attractive targets for a combined utility with no qualms about fuel switching. To gather the most savings possible from energy efficiency and thus the greatest benefit to the taxpayers, Federal customers are likely to need to pursue gas conservation and possibly fuel switching at some point. However, the TPU-Fort Lewis partnership illustrates that the utility does not need to fund those improvements that do not provide direct benefits to the utility.

A particularly attractive feature of the model program

<b><i>Similar Projects</i></b>	<b><i>Federal Customer</i></b>	<b><i>Utility Cost Share</i></b>
Niagara Mohawk Power	Fort Drum, Griffiss AFB	0%
San Diego Gas & Electric	Pendleton MCB	50%
Sacramento Municipal Utility District	McClellan AFB	70%
Boston Edison	Hanscom AFB	100%

design is the ability to modify the level of cost-sharing. This level can be modified on a utility by utility basis or even on a measure by measure basis. The latter case allows a utility to pay a higher percentage for a resource deemed more valuable due to its magnitude or persistence.

#### **SIMILAR EFFORTS**

Tacoma Public Utilities has engaged a number of its other major customers, such as Kraft Tacoma Simpson and Atochem North America, in similarly customized, albeit smaller scale retrofits for efficiency under the utility's Energy Savings Plan (ESP) program. (See Profile #18.) The ESP program targets energy savings from lighting applications, motors, and transformers. Annual energy savings reached 14,557 MWh for the six ESP participants during 1992. [R#2]

The Fort Lewis project is being closely watched by the Federal government as it is the furthest developed of all the applications of the model program. Four other utilities have agreed to implement similar projects at five bases as

shown in the attached table. An additional six utilities have agreed in principle to implement the program but the details of cost-sharing and the contracting remain to be completed. These utilities are Atlanta Gas Light, Baltimore Gas & Electric, Georgia Power Company, Madison Gas & Electric, Southern California Edison, and TU Electric. [R#6]

It is interesting to note that none of these utilities has access to an explicit payment plan for the energy savings that City Light enjoys under the Bonneville Power Administration's Targeted Acquisition Program. However, each is theoretically able to sell the energy savings to other customers. In fact, this may prove to be lucrative to the utility as Federal customers of the magnitude of a major armed forces installation typically pay lower rates than other customers. Such an opportunity to redistribute power sales may prove to be a competitive advantage in future years for a utility, allowing it to make sweetheart deals to entice new industries, to wheel the excess power to other markets, or to stabilize the existing economy by keeping the military base viable in the face of base closures and expense cutbacks. ■

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