

East Hartford Housing Authority

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Companies

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*PPL SavageAlert, Inc*  
*Millennium Builders, Inc*

*April 2, 2012*

# **PPL SavageAlert**

***King Court***  
***Energy Audit***

East Hartford Housing Authority



April 2, 2012

Mr. Andre Dumas  
Modernization Manager  
East Hartford Housing Authority  
546 Burnside Avenue  
East Hartford, CT 06018

Reference: King Court – Energy Audit

Dear Mr. Dumas:

Attached please find our energy audit report for King Court.

Our report has found two viable energy conservation measures (ECM's) that would be self-funding entirely from utility savings. These measures include:

1. Setback Thermostats
2. Low Flow Toilets

We also have determined that there would be substantial energy savings by replacing the windows and boilers at King Court. These ECM's however is not fully self-funding and would require a capital contribution from the Authority.

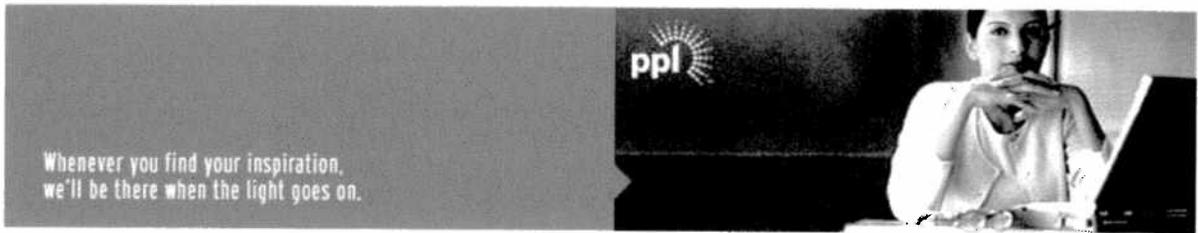
The Tenants pay for their own gas heat and hot water, therefore any energy program that would be funded with energy savings would involve recalculating current tenant utility allowances and modifying rent calculations in order to capture the savings.

If you have any question or require any additional information please contact me at 860-513-1036, Extension 109.

Sincerely

A handwritten signature in black ink, appearing to read 'Donald Proto', written over a white background.

Donald Proto  
Project Developer



Whenever you find your inspiration,  
we'll be there when the light goes on.

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## ENERGY CONSERVATION PROGRAM EXECUTIVE SUMMARY

### ENERGY SOLUTIONS PLAN

The East Hartford Housing Authority (EHHA) faces the same challenges as other public housing authorities across the country — managing the serious need for repairs, improvements, and equipment replacements with tightening operating budgets, while providing comfortable, safe, and wholesome housing for its residents. To address this challenge, EHHA retained the services of PPL SavageAlert to provide an energy audit for King Court.

Based on the findings of this Energy Audit PPL SavageAlert would recommend that EHHA give careful consideration to issuing a request for proposal for an Energy Performance Contract with a qualified Energy Services Company, (ESCO) to develop some or all of the potential energy conservation measures (ECM's) that are identified in this audit report.

PPL SavageAlert began the Comprehensive Energy Audit (CEA), which included the following:

- Analysis of existing systems and equipment
- Analysis of baseline utility consumption levels
- Analysis of the energy and water savings potential
- Development of energy conservation measures (ECM) that meet the needs of the Authority
- Identification of utility and State incentives to meet the financial requirements of the EPC
- Assessment of the financial viability of the EPC

Our CEA findings identified a comprehensive project scope totaling over \$746,159 in facility improvements, with total first year savings of \$47,530. These improvements include boiler upgrades, DHW upgrades, plumbing fixture upgrades, programmable thermostats and new windows. This entire project will be funded over a 15-year contract term. In addition to lowering utility costs, the equipment installed under this EPC will improve reliability, reduce maintenance burden on EHHA staff, and improve resident comfort. The infrastructure improvements implemented under this EPC will free up significant dollars from EHHA's already stretched Capital budget.

### PROJECT HIGHLIGHTS

- **Total infrastructure improvements of \$746,159**
- **Total first year energy savings of \$47,530**
- **New boiler systems for each building.**
- **New indirect domestic hot water heaters**
- **New toilets for water conservation.**
- **New Setback Thermostats will regulate temperatures while saving energy and money**
- **Provide approximately 51% of total project cost with an Energy Performance Contract**

## OVERVIEW OF PROPOSED PROJECT

PPL SavageAlert proposes a comprehensive group of ECM's for the properties at EHHA, as shown in the table below. The project offers EHHA attractive economic performance, with savings exceeding payments over the entire 15-year contract term. The cost's and savings listed below are preliminary budgets subject to final design.

ECM #	ECM Description	ECM Budget	Annual Savings	Simple Payback
01	Setback Thermostats	\$13,920	\$3,744	3.7 yrs
02	Low flow Toilets	\$38,000	\$18,997	2.0 yrs
03	Replacement Windows	\$327,466	\$9,648	33.9 yrs
04	High Efficiency Boilers	\$366,773	\$15,141	24.2 yrs
	<b>Total</b>	<b>\$746,159</b>	<b>\$47,530</b>	<b>15.7 yrs</b>

## BENEFITS TO EAST HARTFORD HOUSING AUTHORITY

A potential EPC energy savings program provides EHHA with a comprehensive energy project, and guaranteed energy savings throughout the project term. Project benefits include:

- Comprehensive capital improvements that reduce energy and water consumption
- Partial solution to shrinking State subsidies
- Reduced maintenance burden on EHHA staff
- Equipment standardization limits the number and types of replacement parts and equipment in the East Hartford PHA inventory
- Reduce exposure to escalating utility rates and costs
- Increase services and quality of life for residents
- Improve community perception of East Hartford PHA

## **ENERGY CONSERVATION MEASURES PROPOSED**

### **ECM-01: Set Back Thermostats**

PPL SavageAlert proposes installing setback thermostats in all units.

To maximize energy savings without sacrificing tenant comfort, new setback thermostats will be installed and may be relocated, if necessary. Improper location of the thermostats can compromise their performance and efficiency. Thermostats will be installed away from direct sunlight, drafts, doorways, skylights, and windows.

If desired, the thermostats can be furnished with the ability to have EHHA management set the upper or lower limit thermostat temperature.

### **ECM-02: Low Flow Plumbing**

PPL SavageAlert proposes to replace 80 existing sanitary water fixtures with new pressure assist 1.1 gpf ultra-low flow ADA toilets (ULFTs). This will allow the EHHA to standardize their inventory.

### **ECM-03: New Windows**

PPL SavageAlert proposes to replace the existing windows in the buildings with a new energy efficient system. The new windows will be comprised of double-pane low-emissivity ("low-e") argon-filled glazing in new vinyl frames.

The new glazing will have a U-factor of about 0.26 to 0.30, which will reduce the conduction heat transfer considerably. The glazing will have a shading coefficient of 0.55. Compared to the existing glazing, with a shading coefficient of 0.80, the new glazing will reduce the solar radiant heat gain by about 37.5 percent.

### **ECM-04: High Efficiency Boilers**

PPL SavageAlert proposes to replace the existing individual hot water boilers with appropriately sized gas-fired boilers in each of the existing boiler rooms that will provide hydronic heating to each unit.

The new boilers will have higher efficiencies due to better heat transfer, better insulation, tighter operating controls associated with state-of-the-art burner controls for full modulation, condensing operation. As an added benefit, the new boilers will provide redundant heating capacity for the building. The existing radiant heating systems on the second floor of the four family buildings will be replaced with baseboard hot water units.

### **SUMMARY**

The potential EPC proposed in this audit represents attractive opportunity for EHHA to implement a comprehensive program that will meet and exceed all EHHA and HUD/CHFA requirements, deliver valuable energy savings, infrastructure and environmental upgrades, and make the EHHA a model housing authority due to its commitment to energy and water efficiency.

The East Hartford Housing Authorities goal should be to leverage the CHFA grant/loan dollars by reducing energy and operating costs and to maximize infrastructure improvements. These investments will help EHHA better manage energy usage and maintain consistent levels of comfort and an improved quality of life for the residents.

**SECTION A**  
**DESCRIPTION OF EXISTING CONDITIONS STATE DEVELOPMENTS**

This audit is for MR-23, King Court. This development is a DECD/CHFA project. Dwelling unit distribution is listed in the table below.

**Table 1. Dwelling Unit Distribution**

Development	Buildings			Housing Type	Total Area (sq.ft.)	Dwelling Units	Units by No of Bed rooms					
	High Rise	Low Rise	Total Buildings				0	1	2	3		
MR-23:King Court	-	1&2 stories	33	Family	67,750	80	-		54	26		-
<b>Totals</b>	-		<b>33</b>			<b>80</b>	-	-	<b>54</b>	<b>26</b>		

Table 2, below, provides a further summary of the two sites, including mechanical, electrical, and site considerations.

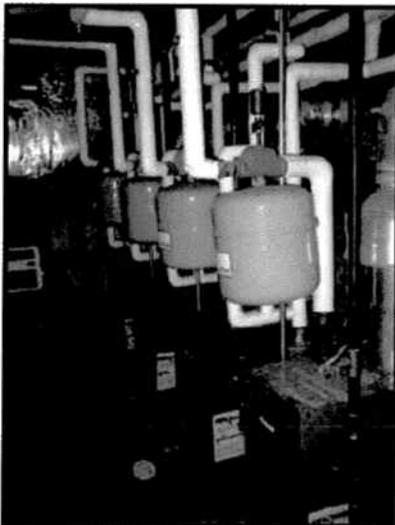
**Table 2. Summary of Mechanical, Electrical, and Water Distribution**

CT #	Development Address	Overview	Electrical System	HVAC System	Water System
23	Veteran's Terrace Columbus Circle	33-1&2 story buildings 80 units 67,750 S.F. Constructed – 1952	Individually metered 100 amp load centers	Individual Boiler for each unit	House Meter

## KING COURT

Development Name	KING COURT
Development Number	23
Type of Structure(s)	Wood Frame with brick veneer
Tenant Classification	Family Development
Year Completed	1952
Number/Type of Dwelling Units	80 Units; 2-3 BR
Number of Bedrooms	186
Approximate Plan Area	67,750 Square Feet
General Location	King Court Drive

### Heating/Cooling



Each apartment unit has its own separate forced circulation hot water heating system. The boilers are located in the basement of each unit. In the case of the four-plex buildings there is a separate boiler room in the basement. The boilers are gas-fired units controlled by one thermostat on the first floor and one on the second floor. Proper rated pressure relief valves are in place as is the flow control valve. The air cushion or Expansion tank is located above the boiler and is in good condition. Some of the heating systems were upgraded in 1993 and the balance in 1998 and they should function well for the next thirteen (13) to eighteen (18) years.

The four-plex buildings have a radiant hot water heating system on the second floor of each apartment that is original to the construction and should be replaced with baseboard hot water radiation units.

The boilers have a single stage boiler control unit that provides hot water control with outdoor reset, set point and DHW for hydronic temperature control. The thermostats in the apartment units are standard wall mounted units with no setback capabilities.

Heating component:

H.B. Smith – 75,000 BTU/HR Net Rating

Cooling component:

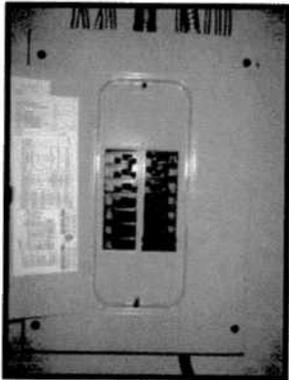
None

## Domestic Hot Water



Separate gas fired hot water heaters in the basements of the buildings provide domestic hot water. There appears to be adequate combustion air in the basements to provide proper function of the gas fired units. Hot water for heat and domestic use is distributed throughout the building by means of copper piping. The domestic hot water heaters are in good condition and are replaced as needed.

## Lighting, Water Conservation and Building Envelope



Electrical distribution within the buildings is at 110/208 volts. Power distribution throughout the buildings is through copper wiring from various panels to equipment throughout the building. The plans indicate that the various panels are supplied with power through copper service conductors.

Panels serving the facility ranged in size from 100 to 200 amps and contained circuit breakers of various sizes, depending on load. Power for receptacles and lighting is derived from various step-down transformers, typically located in mechanical and electrical rooms. The entire project under-went an electrical upgrade in 2000.

GFCI (ground fault circuit interrupter) receptacles are installed.

### Lighting:

Apartment lighting fixtures were replaced in 2000 when the electric systems were upgraded. Kitchen lights are surface-mounted fluorescent fixtures containing 2 lamps. The bathroom lighting is by fluorescent wall fixtures. The electric bills are paid by the tenant's.

### Water Conservation:

The bathroom toilets consist of mix of 2.5 gpf to 1.6 gpf toilets. It is estimated that approximately five percent of the existing toilets are 1.6 gpf fixtures. The shower heads and aerators have not been replaced.

Building Envelope:

The entrance doors are wood. Many of the rear doors have single pane 1/8 inch glass vision panels. The windows were replaced in 1984 and are aluminum double hung windows with insulated glass and integrated screens. The frames are not thermally broken.

The entry door in both the front and rear of the buildings are worn and past their useful life. Many have cracked panels and missing weather stripping. The rear glass in the kitchen doors is not energy efficient even with the existing storm doors. The storm doors appear to be in mostly fair to poor condition.

**SECTION B**

**DESCRIPTION OF PROPOSED ENERGY CONSERVATION MEASURES**

This section presents estimated savings and implementation costs for the proposed package of energy conservation measures (ECMs). Savings were calculated by establishing utility use under existing conditions as the baseline, and comparing utility consumption with proposed ECMs implemented. Savings is the difference between these two conditions.

Some ECMs, particularly HVAC measures, are weather-dependent; for these ECMs, analyses that account for weather effects were used to estimate savings. This method is consistent with industry accepted guidelines and HUD regulations, as provided in 24 CFR IX, Subpart C.

To evaluate the financial feasibility of ECMs, cost estimates were developed using RS Means Cost Data, adjusted for geographic location and local conditions. These estimates represent the project costs that can be expected from subcontractors as well as engineering design, construction administration, general contracting fees, and other project costs that are consistent or exceed CHFA Design Standards.

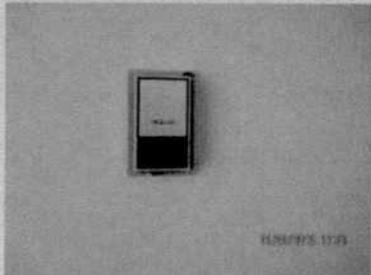
#	ECM	Budget	Savings	Simple Payback
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4	High Efficiency Boilers	\$366,773	\$15,141	24.2
	<b>TOTALS</b>	\$746,159	\$47,530	15.7

## ECM-01: INSTALL ELECTRONIC SETBACK THERMOSTATS

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Setback Thermostat



### MEASURE OVERVIEW

PPL SavageAlert surveyed both King Court and found that many of the existing thermostats are outdated and in need of replacement. Thermostats that are not correctly calibrated can be off by 5°F or more, resulting in building overheating. This temperature difference results in greater than needed demand on the existing heating and cooling systems, as well as wasted energy. The existing thermostats also lack setback capability that would provide the ability to lower space set points during unoccupied or overnight periods.

Additionally, thermostats are available where the upper or lower limit thermostat temperature can be set by EHHA building management. In reality, management can limit it to a lower heating temperature set point. Significant savings can be achievable without an increase in hot or cold complaints calls.

### EXISTING CONDITION

The thermostats are standard thermostats that are located on the walls of the apartments. PPL SavageAlert anticipates that a significant portion of these thermostats are either out of calibration or in need of repair or replacement.

The thermostats that are not correctly calibrated can be off by 5°F or more, resulting in building overheating. This temperature difference results in greater than needed demand on the heating and cooling systems resulting in wasted electricity consumption. The existing thermostats lack setback capability that would provide the ability to lower space set points during unoccupied or overnight periods.

## RECOMMENDED RETROFIT CONDITION

PPL SavageAlert proposes installing setback thermostats in both developments.

To maximize energy savings without sacrificing tenant comfort, new setback thermostats will be installed and may be relocated, if necessary. Improper location of the thermostats can compromise their performance and efficiency. Thermostats will be installed away from direct sunlight, drafts, doorways, skylights, and windows.

If desired, the thermostats can be furnished with the ability to have EHHA management set the upper or lower limit thermostat temperature.

## SCOPE OF WORK

The scope of work includes the following cost elements:

- Identify and replace 160 thermostats in apartments at King Court. This would include 1 thermostat for each apartment flat and 1 thermostat on each floor of the duplex apartments as part of the new heating distribution system.
- Select new thermostat and heating valve actuator compatible with the heating system.
- Provide engineering, design, and installation labor.
- Provide project management and construction management.
- Conduct system startup, testing, and commissioning.
- Coordinate installation schedule to minimize tenant inconvenience. Where practical, installation will be performed in conjunction with other ECM's.

## ADVANTAGES

- Greater control over building temperature, resulting in electric utility bill savings.
- Improved comfort levels.
- Fuel savings of up to 3 percent per degree per day of heating is achievable.
- Setback type thermostats present an opportunity for greater energy savings during unoccupied and overnight periods.
- Optional high and low limits can be set by EHHA management.

## DISADVANTAGES

- Tenant education may be necessary to gain acceptance.

## ANALYSIS METHODOLOGY

Savings was determined by calculating the amount of gas wasted by overheating the spaces. To determine the energy saved by replacing the existing thermostats, we determined the difference between the annual gas consumption with the old out of calibration thermostats with the new set-setback thermostats. The annual energy savings was calculated using standard ASHRAE methodologies.

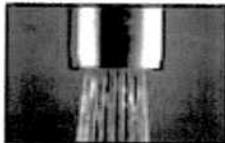
Key assumptions include the following:

- Energy savings were based on a review of descriptive information provided in as-built drawings, discussions with East Hartford HA personnel, and site surveys.
- The efficiency (cooling EER and heating COP) of the existing heat pumps are based on manufacturer's data. Efficiencies of existing equipment have not been degraded for age and condition. HUD does not allow for the provision of cooling in its tenant utility allowance, therefore no savings calculation was provided in our analysis.
- Heating and cooling temperature set points used in thermostat replacement analysis models during setback mode of operation:
  - Family Housing Baseline: 78°F heating,
  - Family Post Installation: 72°F heating,
- Thermostats operate in the setback mode from 10 pm to 6 am seven days per week, year round. Setback temperature set point for family housing is 65°F heating.

## ECM-02: LOW FLOW PLUMBING



**Pressure-Assisted  
Tank Toilet**



**Faucet Aerator**



**Pressure-Compensating  
1.5 gpm Showerhead**

### MEASURE OVERVIEW

PPL SavageAlert conducted a Comprehensive Energy Audit (CEA) of the plumbing fixtures at the East Hartford Housing Authority (EHHA) development known as King Court and found significant water and energy savings opportunities through the upgrade of these fixtures. These upgrades include replacing existing toilets with high-efficiency pressure-assist toilets. The existing showerheads and existing faucets should also be upgraded with low-flow aerators. By retrofitting inefficient toilet fixtures, EHHA will be able to reduce sanitary water consumption by nearly 45 percent.

### EXISTING CONDITION

Water and sewer is provided by the MDC. The Authority pays a sewer use fee at all of its developments. All water bills are paid by the East Hartford PHA.

Existing sanitary water fixtures are older, less water efficient models. The plumbing fixtures in most areas date back to the mid 1980's, when the last bathroom up-grades were completed. Some toilet fixtures have been upgraded to low-flow toilets (LFTs) when a residential unit is unoccupied. However, it appears that there has been no systematic toilet retrofit program implemented. The standard toilets observed during our initial survey average approximately 3.5 gallons per flush (gpf). The low flow models use about 1.6 gpf. It is estimated that EHHA as changed out approximately 5% of the existing toilets with 1.6 gpf low flow toilets. Sink faucets and showerheads varied from residence to residence, but appeared to average around 2.5 gallons per minute (gpm) at both Wilber Peck and Agnes Morley where no low flow shower heads or aerators have been upgraded.

### PROPOSED CONDITION

PPL SavageAlert proposes to replace 80 existing sanitary water fixtures with new pressure assist 1.1 gpf ultra-low flow ADA toilets (ULFTs). This will allow the EHHA to standardize their inventory. PPL SavageAlert also proposes to replace 80 existing shower heads with new pressure-compensating low-flow 1.25 gpm showerheads. In addition, 80 existing bathroom faucet aerators will be replaced with 0.5 gpm vandal resistant aerators and 80 existing kitchen aerators will be replaced with 1.0 gpm vandal resistant aerators. The existing gravity tank toilets are conventional tank types with flapper valves that are subject to frequent and inaudible leakage. We recommend that tank toilets be replaced with pressure-assist ULFTs. Pressurized flush systems will be used to enhance the performance of the toilets and eliminate flapper leaks while exceeding efficiency requirements. A sample of the proposed showerheads and aerators were installed during the design phase so EHHA can have a level of comfort with the proposed new equipment.

The existing gravity tank toilets are conventional tank types with flapper valves that are subject to frequent and inaudible leakage. We recommend that tank toilets be replaced with pressure-assist ULFTs. Pressurized flush systems will be used to enhance the performance of the toilets and eliminate flapper leaks while exceeding efficiency requirements.

Pressure-assist toilets use the potable water system's pressure to compress air within a closed vessel located in the vitreous china tank. When flushed, the compressed air pushes 1.1 gallons of water into the bowl at a high velocity. Compressed air provides a release of energy, creating a strong flush compared to that of a simple gravity flush. This significantly reduces clogging and double flushing. Pressure-assist flushing systems cannot leak like traditional flapper valves, and pressure-assist toilets cannot become "cocked," as is common with chain type tank toilets, which can result in occasional fouling of the toilet valve or continuous running of the toilet until the handle is reset. This pressurized flushing system is virtually maintenance free and has a parts warranty of five to ten years from the date of installation. The vitreous china is warranted for five years.

The faucet aerators in the non-residence buildings will be retrofitted to .5 gpm spray nozzles, which are adequate for hand washing, whereas 1.0 gpm aerators will be installed in the residences to provide for a higher flow for other washing and hygiene needs. We will install vandal-proof aerators for the residence faucets to make the removal of the aerators less likely. This will help to ensure continued savings. None of these changes require an adjustment in operation or in the way people use these devices. The aerators and spray nozzles are warranted by the manufacturer for five years.

We propose replacing existing showerheads with new 1.75 gpm pressure-compensating showerheads. The new showerheads will maintain or increase resident showering satisfaction while being more water efficient. Based on the quantity of water used for showers, this reduction in gallons per minute will provide substantial water and energy savings.

## **SCOPE OF WORK**

The preliminary scope of work includes the replacement of 80 existing toilets, 80 showerheads, 80 bathroom faucet aerators and 80 kitchen aerators at Greenwich PHA. The proposed scope of work will include the following cost elements:

- Removal and disposal of 260 existing toilet fixtures.
- Procurement of materials required for implementation of this ECM, including 80 1.1 gpf toilets, toilet seats, 80 shower heads, and 80 kitchen and bathroom lavatory sink aerators.
- Subcontracting and management of labor required for installation of this ECM.
- Repair of tile required as a result of the installation.

- Any existing damaged shut off valves, shower valves, or similar equipment will be repaired as an extra on a time and material basis. If any items in need of repair are discovered PPL SavageAlert will bring it to the attention of EHHA representatives for approval to conduct the repair.
- Engineering, and design services.
- Project management and construction management.
- System startup, testing, and commissioning.
- Personnel training staff on proper O&M procedures.
- Delivery of complete project closeout documentation, including as-built inventories, equipment listings, and O&M training manuals.
- Warranty all materials and labor during the construction period and pass all manufacturers' warranties on to EHHA at the date of beneficial use.
- Warranty the installation workmanship for one year from the start of beneficial use.

During construction, PPL SavageAlert will carefully coordinate access, security, and phasing to avoid loss of use and to minimize disruption of sanitary service. We understand the importance of this aspect of the project and from our experience with large residential water conservation projects. We will plan and manage construction activities to avoid resident inconvenience.

### **ADVANTAGES**

- New, upgraded sanitary water fixtures, including highly reliable pressure-assist tank toilets.
- All materials backed by a five-year manufacturer warranty and ten-year warranty for the pressure-assist toilets.
- Reduced maintenance costs from new plumbing with longer life, including the removal of flapper valves or Fluidmaster/fill valve seals from tank toilet maintenance requirements.
- Pressure-compensating aerators and showerheads to account for variable site water pressures.
- Reduced water use and, therefore, reduced water and sewer utility expense.
- Reduced domestic hot water load proportional to reduced hot water use through faucets and showerheads.

### **ANALYSIS METHODOLOGY**

Water use is analyzed in a proprietary database model using information collected during the CEA. The data collected, is comprised of an inventory of sanitary fixtures, census/population information, hours of operation, and usage rates<sup>1</sup> of toilets, showers, and faucets. These factors are used to establish the baseline flow rates and the baseline water consumption that is applied to develop savings. Savings are the difference between baseline flow rates and post-implementation flow rates.

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<sup>1</sup> Usage rates are based on water use studies such as "REUWS - Residential End Uses of Water Study," American Water Works Association Research Foundation, Denver, 1999.

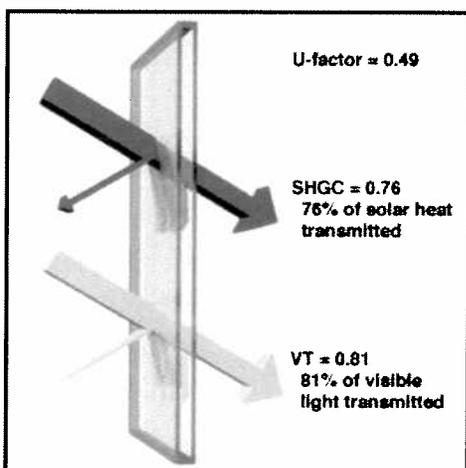
## ECM-03: NEW WINDOWS

### Existing Condition

The Windows at King Court were replaced 28 years ago in 1984. They are aluminum double hung windows with insulated glass and integrated screens. The frames are not thermally broken.

In addition to infiltration of outdoor air, the double-pane glazing is inefficient, with a U-factor of about 0.71 to 0.99. This allows a substantial amount of heat to transfer out through the glass during the winter months and into the space during summer months. Moreover, this glazing system allows much of the sun's radiant heat to penetrate, making building occupants uncomfortable in perimeter areas.

Figure 4-1 illustrates the performance of a typical double-glazed unit with two lites of clear glass. The inner and outer layers of glass are both clear and separated by an air gap. Double glazing, compared to single glazing, cuts heat loss in half due to the insulating air space between the glass layers. In addition to reducing the heat flow, a double-glazed unit with clear glass will allow the transmission of high visible light and high solar heat gain.



### Figure 4a- Double-glazed, Clear Glass

This figure illustrates the performance of a typical double-glazed unit with two lites of clear glass. The inner and outer layers of glass are both clear and separated by an air gap. Double glazing, compared to single glazing, cuts heat loss in half due to the insulating air space between the glass layers. In addition to reducing the heat flow, a double-glazed unit with clear glass will allow the transmission of high visible light and high solar heat gain.

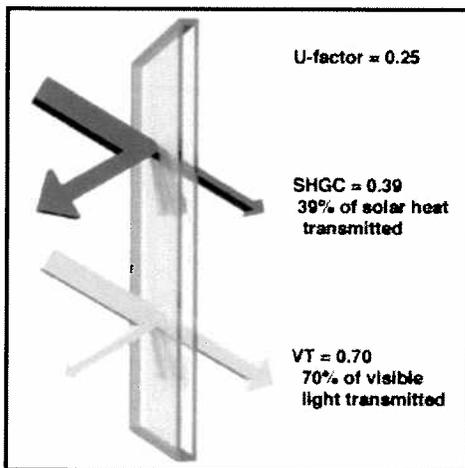
Table 4-1: Whole Window Properties - Double-glazed, Clear Glass

			
Frame	Metal Frame	Metal Frame with Thermal Break	Non-metal Frame
U-Factor	0.71-0.99	0.56-0.70	0.41-0.55
SHGC	>0.60	>0.60	0.41-0.60
VT	>0.60	>0.60	0.51-0.60

**Proposed Condition**

PPL SavageAlert proposes to replace the existing windows in the building with a new energy efficient windows. The new windows will be comprised of double-pane low-emissivity (“low-e”) argon-filled glazing with new aluminum in-fill panels and interior and exterior aluminum trim on existing frames. The infill panels will be insulated. The glazing will be tinted to improve shading properties and aesthetic appeal. East Hartford Housing Authority personnel will be consulted regarding tinting color options.

The new glazing will have a U-factor of about 0.26 to 0.30, which will reduce the conduction heat transfer considerably. The glazing will have a shading coefficient of 0.55. Compared to the existing glazing, with a shading coefficient of 0.80, the new glazing will reduce the solar radiant heat gain by about 37.5 percent.



**Figure 4b- Double-glazed, Low-E Glass, Argon Gas**

This figure illustrates the characteristics of a typical double-glazed window with a moderate-solar-gain low-E glass with argon gas fill. These windows are often referred to as spectrally selective low-E glass due to their ability to reduce solar heat gain while retaining high visible transmittance. Such coatings reduce heat loss and let in a reduced amount of solar gain making them suitable for climates with both heating and cooling concerns.

**Table 4-1: Whole Window Properties – Double-Glazed, Low-E Glass, Argon Gas**

			
<b>Frame</b>	<b><u>Metal Frame with Thermal Break</u></b>	<b><u>Non-metal Frame</u></b>	<b><u>Non-metal Frame, Thermally Improved</u></b>
<b>U-Factor</b>	0.41-0.55	0.31-0.40	0.26-0.30
<b>SHGC</b>	0.26-0.40	0.26-0.40	0.26-0.40
<b>VT</b>	0.51-0.60	0.51-0.60	0.51-0.60

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Apart from energy savings, implementation of this measure will improve the aesthetic appeal of this building remarkably.

### **Advantages**

- Significant energy savings.
- Improved thermal comfort.
- Air sealing of window and door system can be done in conjunction with installation.
- Improved operation and appearance.
- Reduced maintenance

### **Disadvantages**

- May be disruptive to implement in occupied spaces.

### **Health Benefits**

- Window system replacements may eliminate leaks, a potential source of moisture in the building.

### **Preliminary Scope of Work**

The preliminary scope of work includes the following cost elements:

- Provide materials and equipment necessary for complete, in-place, and functioning thermally broken projected and/or double-hung aluminum windows complete with mullions, trim, hardware, and all accessories.
- Provide materials and equipment necessary for complete installation of new insulated glass with aluminum frames.
- Removal of existing window system shall include operable sashes, mullions, glazing, hardware, or other existing construction required for installation of replacement units.
- Replace trim and accessories, such as panning, expanders, or other installation hardware specifically required for replacement work and as required to retrofit existing openings and perimeter frames.
- Provide engineering, design, and installation labor.
- Provide project management and construction management.
- Conduct system startup, testing, and commissioning.
- Provide access, security, and phasing to avoid loss of use.

### **Analysis Methodology**

Energy savings resulting from window system replacement will be determined by calculating the amount of solar heat gain and transmission losses through the existing and proposed windows. Heat loss and heat gains through windows will be calculated using standard ASHRAE procedures. Annual losses will be calculated by applying historical bin weather data and meteorological data for the City of East Hartford. Manufacturer's data for window and sliding glass door thermal performance will be used in the analysis.

Savings associated with improved thermal performance will be analyzed in a spreadsheet model using information collected during the energy audit. The data will be comprised of location, length, and width of crack or void, and penetration characteristics. Infiltration heat loss and gains through building envelope and system components will be calculated using standard ASHRAE procedures.

Key assumptions (to be confirmed during the Energy Audit) include the following:

- Condition and thermal efficiency of existing windows, sliding glass doors, and infill panels.
- Leak rates around assembly.
- Reasonable access to occupied areas.
- Heat is provided to buildings 24 hours/day, 7 days/week from October 1 to May 1.
- East Hartford Housing Authority will retain responsibility for day-to-day maintenance and repair of windows.

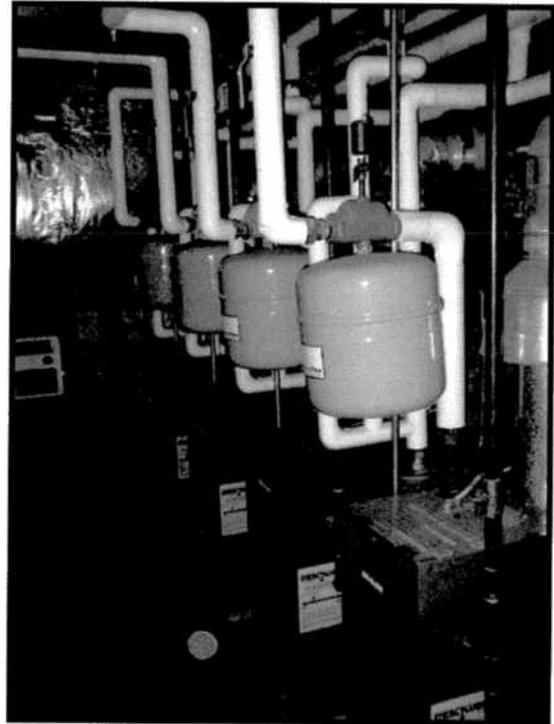
## ECM-04: HIGH EFFICIENCY BOILERS

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### Existing Condition

PPL SavageAlert performed a preliminary survey of the central heating plants at the King Court development in order to assess the opportunity for energy cost savings. The development is currently being served by boilers that supply hot water to the hydronic distribution systems. The existing plants are inefficient in comparison to available technologies.

Each apartment unit is heated by separate Weil-McLain atmospheric boilers, with 105,000 Btu/hr input each. The boilers are well maintained but are old they were installed in the early 1990's and are nearing the end of their useful life.



*Figure 01.1 King Court Boilers*

### Proposed Condition

PPL SavageAlert proposes to replace the existing individual hot water boilers with new high efficiency fully condensing boilers.

The proposed equipment will be designed to match the total heating and domestic hot water demand load more closely, thus resulting in decreased fuel consumption due to higher seasonal efficiencies. All of the new equipment will be installed within the existing mechanical room locations.

The new boilers will have higher efficiencies due to better heat transfer, better insulation, tighter operating control associated with state-of-the-art burner controls for full modulation, condensing operation. All of the new boilers will burn natural gas. The facility will benefit not only from reduced energy consumption, but also increased system reliability and a reduction in maintenance costs.

This ECM will positively impact building occupants by providing better control of space temperature and efficiently matching the equipment capacities with the post-retrofit building loads. Installation of the new boilers and supporting equipment will be done during the non-heating season, so as not to interrupt the daily lives of the tenants.

### **Advantages**

- Newer condensing boiler technology combined with properly sized equipment will increase seasonal operating efficiency significantly.
- More efficient boiler operation at part loads resulting in fossil fuel savings.
- Improved control resulting in improved comfort levels.

### **Disadvantages**

None.

### **Health Benefits**

A reduction in boiler fuel consumption will result in decreased emissions of criteria pollutants and increased boiler efficiency.

### **Preliminary Scope of Work**

The preliminary scope of work includes the following cost elements:

- Demolish and remove existing boilers.
- Disconnect and abandon the radiant ceiling heating loops in the second floor ceiling
- Install new hydronic baseboard hot water heating units on the second floor to replace the ceiling radiant heating system.
- Provide rigging.
- Install new boilers.
- Connect the new boilers to the existing heating distribution and makeup water piping with new connections and valves as needed.
- Install all required pipe insulation, including removable insulation for valves and fittings.
- Install new boiler vent stack.
- Connect the new boilers to high-limit controls to shut off the burners if the operating pressure reaches a predetermined high-limit setting.
- Provide operating controls to start and stop the burners to maintain the boiler pressure.
- Provide pressure and temperature gauges to indicate the boiler pressures and temperatures.
- Install emergency low cut-offs for each boiler.
- Install pressure relief valves of the number and capacity required by ASME code.
- Provide engineering, design, and installation labor.

- Provide project management and construction management.
- Conduct system startup, testing, and commissioning.
- Provide access, security, and phasing to avoid loss of use.

### **Analysis Methodology**

The energy savings for this ECM were determined by modeling the existing central heating plant systems using a building simulation model such as DOE-2 or a spreadsheet model. Modeling the existing central heating plant systems and comparing to the installation of new central heating plant boilers, thus capturing the increased efficiency in generating the space heating requirements, determined the energy savings for this ECM.

During the ESA, we will critically review this scope of work, in association with East Hartford Housing Authority staff, and identify the need for any substantive changes to the work. The energy calculations are based on an end use analysis of the existing and proposed boiler efficiencies.

Key assumptions (to be confirmed during the ESA) include the following:

- Energy savings were based on a review of descriptive information provided in the site data package, discussions with East Hartford Housing Authority personnel, and site surveys. During the ESA, the estimated savings will be verified and additional savings sought.
- Condition of central heating plant equipment, distribution piping, and terminal equipment control.
- Central heating plant hot water is generated for space heating 24 hours/day, 7 days/week, from October 15 to May 15 each year.
- Building heating loads, distribution losses, and central heating plant losses are estimated based on equipment age and condition, site surveys, and discussions with East Hartford Housing Authority personnel. These estimates should be thoroughly investigated during the design phase of the proposed EPC.
- The efficiency of the existing boilers was based on manufacturer's data, adjusted for the age of the boiler.

### **Proposed EPC Work Plan**

- Review proposal and budget with team, draft scope of work, set deliverable schedule.
- Conduct in-depth review of existing documentation with East Hartford Housing Authority engineering and maintenance staff.
- Acquire all supporting detail and computer runs for the energy savings analysis.
- Conduct detailed energy survey of affected equipment and include in model.
- Identify required changes to analysis and design.
- Perform additional analysis as required and confirm savings estimate.
- Review final scope with East Hartford Housing Authority personnel.

- Identify any maintenance savings.
- Prepare M&V plan.
- Prepare construction documents and obtain quotes on new work.
- Obtain East Hartford Housing Authority approval for analysis, M&V, and installation plan.
- Prepare Energy Services Agreement documents for this ECM.

### **O&M and M&V Approach**

Each new boiler plant will be inspected, cleaned, and adjusted at least annually by a qualified trained boiler technician. The ESCO should run diagnostics on new boilers to ensure that they are working properly and that the boilers are operating at optimum efficiency.

PPL SavageAlert would propose using M&V Option C, the Whole Building Approach, to measure and verify savings at each site. With Option C, the ESCO monitors utility meter readings, make appropriate baseline adjustments for weather, occupancy, and use patterns, and calculate changes in consumption to establish overall savings achieved. This method cannot be used to determine savings associated with single ECMs or subsets of ECMs, but rather it is used to determine the aggregate savings of all ECMs' savings of a particular fuel at a single site.

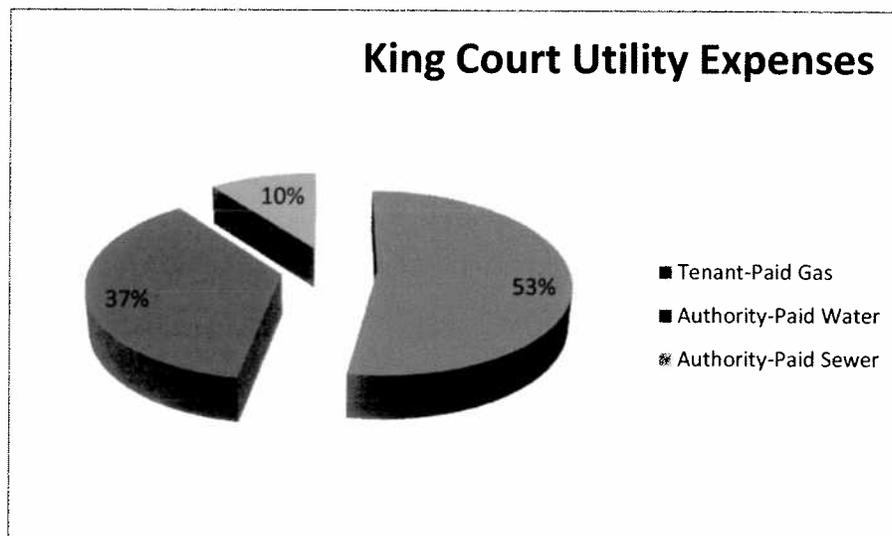
## SECTION C BASELINE ENERGY CONSUMPTION

### UTILITY CONSUMPTION PROFILE

The first step in the baseline analysis is the gathering of all energy consumption data at King Court. This development has a thirty seven percent (37%) vacancy rate. Based on the fact that 30 units are currently vacant and not consuming any water and a minimum of gas for heating we have adjusted the baseline energy consumption levels to reflect a reasonable consumption of utilities by an energy conservative household of modest circumstances consistent with the requirements of a safe, sanitary and healthful living environment.

This audit did not include electrical consumption as electrical lighting upgrades to Authority common areas, exterior lighting and tenant paid lighting fixtures have already been done under the WRAP Program sponsored by CL&P.

Energy use in King Court includes both Authority paid and resident paid utilities. This audit does not address tenant paid electric utilities and only address the water and sewer utilities paid by the Authority and the gas utility paid by the tenants for heat, hot water and cooking. The utility cost allocation between the Authority paid utilities and tenant paid utilities is shown in the chart below.



The table below shows the total adjusted utility consumption for 100% occupancy of King Court:

**Table 1c – Adjusted Utility Consumption 2011**

	Tenant-	Tenant-	Authority-	Authority-	Authority-	Authority-
	Paid	CCF	Paid	Gallons	Paid	CCF
	Gas	Gas	Water	Water	Sewer	Sewer
Totals	<b>\$ 89,094</b>	<b>74,969</b>	<b>\$ 62,525</b>	<b>6,918,497</b>	<b>\$ 17,573</b>	<b>9,249</b>

## PHA Paid Utilities

### OVERVIEW

PPL SavageAlert has collected and analyzed utility data and calculated the water, gas, and electricity baselines for the East Hartford Housing Authority (EHHA) proposed upgrades. These baselines will be used to calculate post construction savings. Details of the data sources used and the methods used for water, gas, and electricity baselines are presented below.

PPL SavageAlert used actual utility billing invoices provided by EHHA for water, CL&P for electricity and CNG for gas consumption. Water and domestic hot water energy use is dependent on tenant and staff usage. PPL SavageAlert normalized consumption data and occupancy dependencies using standard HUD-approved engineering practices.

Utility rates used in baseline energy costs and in savings come from the most recent billing data. Table 1c - Utility Rates, as illustrated below summarize the applicable utility rates by Development. These rates will be used for the savings calculations.

**Table 1c - Utility Rates**

Site Location	2012 Gas Rate CNG	2012 Water Rate	2012 Sewer Rate
King Court	\$1.20 Blended Rate	\$4.86 / CCF	\$1.90 CCF

We used a conservative 3% annual escalation rate for water and sewer rates and 2.5% for gas rates.

### 2010-2011 Actual Consumption Data

The following pages include the base utility data supplied by the East Hartford Housing Authority.

## FINANCIAL SUMMARY

The following is a financial summary for this potential CEA:

- PPL SavageAlert's budgeted cost that were jointly developed with EHHA for ECM's 1 through 4 as identified in Section B is \$746,159. This does not include any financing charges by EHHA's financier.
- Estimated annual savings for this EPC is \$47,530 which includes gas and water savings from both the Tenant Utility Allowances and EHHA paid utilities.
- Construction duration is estimated to be 12 months from the execution of a potential ESA to final acceptance.
- The project term is 15 years, commencing at project acceptance.

A summary of project costs and savings are shown in **Table 1-D: Cost and Savings by ECM**. A Financial Proforma is presented in **Attachment D1: Project Proforma** and is discussed in further detail in this section.

Table 1-D: Cost and Savings by ECM

		ECM Budget	Annual Savings	Simple Payback
1	<b>Setback Thermostats</b>	\$ 13,920	\$ 3,744	3.7 Yrs
2	<b>Low Flow Toilets</b>	\$ 38,000	\$ 18,997	2.0 Yrs
3	<b>Replacement Windows</b>	\$ 327,466	\$ 9,648	33.9 Yrs
4	<b>High Efficiency Boilers</b>	\$ 366,773	\$ 15,141	24.2 Yrs
<b>TOTAL</b>		<b>\$ 746,159</b>	<b>\$ 47,530</b>	<b>15.7 Yrs</b>

## BASIC FINANCIAL FRAMEWORK OF PROPOSED EPC

### Energy Savings Funding Program

PPL SavageAlert understands the intent of East Hartford Housing Authority to utilize an Energy Performance Contract as part of a mixed financed capital improvement program for the King Court Development. This project can be partially funded through the savings achieved with an energy performance contract savings guarantee. The program will require approximately \$350,000 grant or equity capital for non-energy related costs to cover a portion of the windows and heating systems.

### Guaranteed Savings

One of the most important elements of the EPC is the savings guarantee to EHHA over the 15-year contract term. The ESCO selected by EHHA guarantees to EHHA that actual verified savings will equal or exceed the total of debt service payments and the ESCO Services on an annual basis. If the verified savings are less than this guaranteed amount, the ESCO will reimburse EHHA for 100 percent of the shortfall. The potential guaranteed amounts by contract year are summarized in **Attachment D1: Project Proforma**. The guarantee should be reconciled at the end of each contract year using the M&V procedures outlined in HUD's Guidance for M&V in Appendix 1 of this proposal. A reconciliation of

the guaranteed savings upon completion of installation of the ECMs shall take place as described under *As-Built Reconciliation*.

### **As-Built Reconciliation**

It is common to encounter changes in scope for large-volume measures such as lighting upgrades, water fixtures, thermostat replacements, etc. The actual installed scope, such as quantities of fixtures, may vary from the quantities listed in this Comprehensive Energy Audit (CEA) and subsequent Energy Performance Contract (EPC). Most ESCO's routinely process the impact of these changes after installation is complete, using "quantity reconciliation" or "true-up" approach when preparing as-built documentation and as-built financials. The actual quantities installed will be documented as construction proceeds and reviewed during construction meetings. Throughout the installation, the ESCO will continuously evaluate the financial impact (costs and savings) of the changes using unit cost and unit savings as identified in the CEA and will keep EHHA aware of these changes. Should quantities vary greater than 10 percent of the quantities in the CEA, the ESCO will seek approval from EHHA prior to proceeding. At construction completion, actual installed quantities will also be used in the close-out documents to ensure that calculated energy savings are based on as-built conditions. By doing as-built reconciliation, EHHA is assured that costs and savings accurately reflect the actual quantities installed.

### **Project Financing**

It is proposed that financing will be arranged by EHHA using a Municipal Tax Exempt Lease. PPL SavageAlert will work with EHHA in its efforts to procure financing. The proforma provided in this proposal is based on PPL SavageAlert's estimated debt service payments over a 15-year contract term using a 4.58 percent estimated interest rate. The proforma will be updated with final rate information once EHHA and the financier execute the Municipal Tax Exempt Lease Agreement. After EHHA has selected a financier, PPL SavageAlert requests that EHHA make available to PPL SavageAlert a copy of the financing terms and conditions and an amortization schedule. PPL SavageAlert will use the information to update and finalize the guaranteed savings amount, which covers the debt service payment to the financier.

### **PROFORMA**

The proforma consists of the following columns: (please refer to **Attachment D1: Project Proforma**, which details the projected cash flows over a 15-year contract term).

1. Contract Year: This shows the 15 years of performance, with Year 1 starting with the final acceptance date as evidenced by the Certificate of Final Acceptance from EHHA.
2. Estimated Annual Savings: The total estimated savings from all ECMs included in this EPC using the agreed upon annual utility escalation rate of 4 percent. Savings in Year 1 include the utility escalation during the construction period.
3. Debt Service (Lease Payments): The Debt Service column includes the annual payments by EHHA to its financier, which is comprised of principle, interest, and any financier fees. It is currently an estimate by PPL SavageAlert and will have to be updated with the amortization schedule from EHHA's financier. PPL SavageAlert guarantees that savings will be adequate to cover the debt service and PPL SavageAlert service payments on an annual basis.
4. The ESCO Service Phase Costs: This includes the ESCO's annual service phase costs for the services described below. An annual escalation rate of 3.25 percent has been used.

- a. ESCO's O&M compliance services ensure that the installed equipment is being operated and maintained properly by EHHA personnel so that the savings persist over the 15-year contract term.
  - b. ESCO's M&V services provide proof that EHHA is realizing the guaranteed annual savings based on the M&V methods described in the EPC proposal. This effort will provide the Annual Verification Report, which is the basis for ensuring that the ESCO has fulfilled its savings guarantee obligations for that year.
5. Operations & Maintenance: The ESCO's or PHA Vendors fee for providing yearly maintenance on the boiler systems.
  6. Total Program Cost: This includes the total of all annual lease payments, O&M compliance services , M&V services fees and Utility Allowance Updates.
  7. Ratio of Program Costs to Savings: Because this is not a HUD subsidized development this column may not be relevant but it is left in place to illustrate that the program as proposed would comply with current HUD regulations. This is the ratio of the total EPC Program costs to estimated savings. It is relevant when using the frozen base incentive and resident paid incentive, especially if this ratio falls below 75% in any year. HUD only allows the PHA to keep up to 25% of the savings and expects that at least 75% be used for debt service and other EPC program expenses.
  8. Net Cash Flow to EHHA: This column is the difference between Estimated Annual Savings and Total Program Costs. A positive number in each year means that a self-funding program exists, whereby savings exceed all EPC program costs in each year of the term. Amounts in this column are for EHHA to keep (subject to the 75/25 discussion under frozen incentives earlier in this section).
  9. Ratio of Program Savings to EHHA: Because this is not a HUD subsidized development this column may not be relevant but it is left in place to illustrate that the program as proposed would comply with current HUD regulations. This is the ratio of the total EPC savings to EHHA. It is relevant when using the frozen base incentive and resident paid incentive, especially if this ratio exceeds 25% in any year. HUD only allows the PHA to keep up to 25% of the savings if the savings exceeds 25% in any given year HUD would be entitled to the excess of the 25%. and expects that at least 75% be used for debt service and other EPC program expenses.
  10. Annual Savings Guarantee: Under the HUD Energy Performance Contract program the ESCO is required to guarantee the savings required to cover both the lease payment and the ESCO's services.

**ATTACHMENT D1: Project Proforma**

**Project Proforma - EHHA / King Court**

\$	746,159	Total Construction Value (including Audit)
2%	15,000	Utility Incentives
47%	350,000	EHHA Capital Contribution
51%	381,159	Financed Amount

Term of Contract	Years: 15
Interest Rate:	4.58%
First Yr. Savings:	\$47,530

Col.1	Col.2	Col.3	Col.4	Col.5	Col.6	Col.7	Col.8	Col.9	Col.10
Year	Estimated Annual Savings	Financier Debt Service (Lease Payments)	PPLSA Annual M&V Service and Maintenance Oversight	Operations & Maintenance	Total Program Cost	Ratio of Program costs to Savings (Minimum Requirement 75% HUD)	Net Cash Flow to HATG	Ratio of Program Savings to HATG (Maximum Requirement 25% HUD)	Annual Savings Guarantee (Debt Service plus PPL Services)
1	\$47,530	\$35,687	\$8,300	\$ -	\$43,987	93%	\$3,543	7%	\$43,987
2	\$48,481	\$35,687	\$8,466	\$ -	\$44,153	91%	\$4,328	9%	\$44,153
3	\$49,450	\$35,687	\$8,635	\$ -	\$44,322	90%	\$5,128	10%	\$44,322
4	\$50,439	\$35,687	\$8,808	\$ -	\$44,495	88%	\$5,945	12%	\$44,495
5	\$51,448	\$35,687	\$8,984	\$ -	\$44,671	87%	\$6,777	13%	\$44,671
6	\$52,477	\$35,687	\$9,164	\$ -	\$44,851	85%	\$7,626	15%	\$44,851
7	\$53,526	\$35,687	\$9,347	\$ -	\$45,034	84%	\$8,493	16%	\$45,034
8	\$54,597	\$35,687	\$9,534	\$ -	\$45,221	83%	\$9,376	17%	\$45,221
9	\$55,689	\$35,687	\$9,725	\$ -	\$45,411	82%	\$10,278	18%	\$45,411
10	\$56,803	\$35,687	\$9,919	\$ -	\$45,606	80%	\$11,197	20%	\$45,606
11	\$57,939	\$35,687	\$10,118	\$ -	\$45,804	79%	\$12,135	21%	\$45,804
12	\$59,098	\$35,687	\$10,320	\$ -	\$46,007	78%	\$13,091	22%	\$46,007
13	\$60,280	\$35,687	\$10,526	\$ -	\$46,213	77%	\$14,066	23%	\$46,213
14	\$61,485	\$35,687	\$10,737	\$ -	\$46,424	76%	\$15,062	24%	\$46,424
15	\$62,715	\$35,687	\$10,952	\$ -	\$46,638	74%	\$16,077	26%	\$46,638
<b>TOTAL</b>	<b>\$821,956</b>	<b>\$535,300</b>	<b>\$143,535</b>	<b>\$ -</b>	<b>\$678,835</b>	<b>83%</b>	<b>\$143,121</b>	<b>17%</b>	<b>\$ 678,835</b>

Energy Escalation Rate: 2.0000%

## PROCESS

The following illustrates the discrete steps and milestones from execution of the ESA to project acceptance:

1. After all approvals (EHHA, DECD, CHFA, HUD, and the ESCO) are complete, the ESA is executed by EHHA and the ESCO. EHHA will have financing in place at the time of ESA execution.
2. EHHA issues a Notice to Proceed (NTP).
3. The ESCO contracts with subcontractors, vendors, etc.
4. The ESCO continues to evaluate the financial health of the project, i.e., the guaranteed savings shall be no less than 100 percent of the amount required to cover the debt service payments over the term of the EPC.
5. The ESCO performs percent complete progress billing on monthly completion. An EHHA designated person and/or Lender approves invoices to be paid from escrow.
6. After substantial completion, defined as the date when the work is sufficiently complete so the ECM(s) can perform as intended, the ESCO will request a signed Certificate of Substantial Completion from EHHA. This will initiate equipment warranties.
7. Final Invoice and As-Built Documentation – the ESCO will submit a final invoice reflecting any changes due to as-built reconciliation, with the following documentation:
  - a. As-built financials showing as-built costs and savings per ECM broken down by development as described under as-built reconciliation.
  - b. As-built documentation as applicable.
  - c. Commissioning and M&V reports.
  - d. Equipment warranty information.
8. The ESCO requests project acceptance from EHHA. Signed acceptance by EHHA is the Commencement date for the service phase of the project. The ESCO performs the service phase responsibilities. EHHA shall make annual payments to The ESCO at the beginning of each contract year (for that contract year) for the service phase expenses.