Energy Performance Contracting in HUD's Public Housing Stock:

A Brief Overview

U.S. Department of Housing and Urban Development | Office of Policy Development and Research

Energy Performance Contracting in HUD's Public Housing Stock:

A Brief Overview

U.S. Department of Housing
and Urban Development

Office of Policy Development and Research

Affordable Housing Research
and Technology Division

Prepared by

Michael J. Early

Michael D. Blanford

Will R. Zachmann

Barry L. Steffen

June 2017

Acknowledgments

Energy Performance Contracting in HUD's Public Housing Stock: A Brief Overview has benefited from the generous contributions of many individuals. Development of this report was made possible by funding from the U.S. Department of Housing and Urban Development (HUD), Office of Policy Development and Research (PD&R). The authors particularly appreciate the thoughtful support and advice provided by Elizabeth Cocke of PD&R's Affordable Housing Research and Technology Division. They thank Christopher Golden of the HUD Office of Public and Indian Housing for his insight and guidance, and they are indebted to the leaders and staff of the housing authorities we visited: Wilmington Housing Authority (DE001), Clinton County Housing Authority (PA040), Greenwood Housing Authority (MS107), North Little Rock Housing Authority (AR002), Kansas City, Kansas Housing Authority (KS001), Denver Housing Authority (CO001), Housing Authority of the County of Chester (PA046), Metropolitan Development and Housing Agency (TN005), and Watervliet Housing Authority (NY025). They also thank all those who reviewed the report and provided helpful comments. Without the combined efforts of all those listed, this report would not have been possible.

Disclaimer

The contents of this report represent the views of the authors and do not necessarily reflect the views or policies of the U.S. Department of Housing and Urban Development or the U.S. government.

Preface

The U.S. Department of Housing and Urban Development (HUD), Office of Public and Indian Housing (PIH) administers the Energy Performance Contracting (EPC) program, an innovative approach to providing Public Housing Authorities (PHAs) with the financial flexibility to install cost-effective, utility-related improvements with little or no upfront expenditure.

Since the EPC program's inception in the 1980s, PIH reports that approximately 315 EPCs (affecting approximately 250,000 units) have been approved, representing nearly $1.5 billion in utility cost reduction investments. These performance contracts have been executed in all 10 HUD regions and in PHAs with sizes ranging from very small (fewer than 250 units) to very large (6,600 units or more); however, no substantive review of program performance has been conducted.

To better understand how EPCs have helped improve conditions and reduce operating costs in our nation's public housing stock, a multidisciplinary team from HUD's Office of Policy Development and Research undertook a pilot study to assess the program's overall effectiveness and value. The research team's findings and observations provide PIH with a set of proposed actions that could significantly expand the adoption of EPCs within the PHA community. By giving PHAs the financial flexibility to use resultant utility cost savings to fund utility-related capital improvements, EPCs encourage PHAs to make more strategic and comprehensive utility upgrades than limited capital funding would otherwise support.

I do hope that PIH policymakers will carefully consider the research team's observations and use them to inform policies that will encourage and support more PHAs to use the EPC program as a viable tool for improving the properties under their control.

Contents

List of Tables

List of Figures

Executive Summary

This report summarizes an exploratory study of the effectiveness and value of the U.S. Department of Housing and Urban Development (HUD), Office of Public and Indian Housing's (PIH's) Energy Performance Contracting (EPC) program. In August and September 2015, HUD's Office of Policy Development and Research (PD&R) staff made onsite visits to nine public housing authorities (PHAs) that have either executed a new EPC or exercised an option to an existing EPC in place since 2010. The research effort compiled and analyzed data derived from a questionnaire for PHA staff, in-person discussions with PHA staff, an inspection of EPC-installed improvements, a collection of EPC documents, and discussions with multiple participants in the field of energy performance contracting.

During the development of the research protocol, PIH requested that we explore three policy-related issues that could be informed by the study:

1. Whether to allow PHAs to use utility savings from EPCs for non-energy-related or non-water-related capital improvements.
2. Whether to provide a compensatory fee to PHAs that choose to self-manage their EPC.
3. Whether the degree of rigor of the EPC application process is necessary to ensure the cost-effectiveness of projects.

The findings from this research helped PD&R understand the strengths and weaknesses, regulatory intent, and general effectiveness of the EPC program. We developed a set of observations to assist HUD in improving the EPC program. Because the study involved a relatively small and therefore unrepresentative sample of PHAs, PD&R may revise these suggestions based on the results of its forthcoming nationwide study of the EPC program, which is intended to provide a more conclusive evaluation and better understanding of the program's value and overall effectiveness.

Both the current project and the proposed evaluation efforts will be key to HUD's long-term strategies for reducing utility consumption within its housing portfolio, in part because the EPC program is being affected by the advent of HUD's Rental Assistance Demonstration (RAD), which removes certain units from HUD's public housing inventory and therefore from the EPC funding stream.

The PD&R team drew on findings from the current study to develop the following set of observations for PIH:

- The nine PHAs visited are not a perfect representation of the 247 PHAs that have executed an EPC project. But they have enough diversity in size and experience for us to make some observations about the EPC program.
- The EPC program has provided value to the nine PHAs studied. Eight of the nine participants felt the program to be (1) a benefit to their housing authority, (2) to have funded improvements that otherwise would not have been made; and (3) either was outperforming or performing as projected. Five of the housing authorities reported cost savings in excess of the EPC debt service.

- Our conversations with these nine PHAs and discussions with program staff suggest some areas that are working well and others that might be improved.
- The rigorous application process is clearly important for both the PHAs and HUD. The application is key to program success. Yet the burden and challenge of completing an application could be lessened by HUD establishing with its Technical Assistance funds a peer learning network that connects some of the 247 PHAs that have successfully implemented EPCs with PHAs applying for the first time. For example, that peer network could provide guidance on how to design EPC projects that will not unduly harm a PHA's operating budget when there are HUD Operating Fund shortfalls.
- The program could be slightly less burdensome, and more appealing to PHAs, if fewer restrictions were put on how PHAs can use their cost savings, currently they are limited to spending those cost savings on either energy or water savings improvements. Perhaps this flexibility could be offered as an incentive to PHAs if they self-manage their EPC. Self-management appears to improve oversight and efficiency.

Finally, there are a number of likely improvements to the metrics and data being collected by HUD from the PHAs that would provide better information on the benefits and costs of the performance contracts.

Introduction

Objective

This report summarizes an exploratory study of the effectiveness and value of the Office of Public and Indian Housing's (PIH's) program on Energy Performance Contracting (EPC).[1] During fiscal year (FY) 2015, staff from HUD's Office of Policy Development and Research (PD&R) made site visits to nine public housing authorities (PHAs) that have executed an EPC. The research effort compiled and analyzed data derived from a questionnaire for PHA staff, in-person discussions with PHA staff, an inspection of EPC-installed improvements, a collection of EPC documents, and discussions with multiple participants in the field of energy performance contracting.

During the development of the research protocol, PIH requested that we explore three policy-related issues that could be informed by this study.

1. Whether to allow PHAs to use utility savings from EPCs for non-energy-related or non-water-related capital improvements.
2. Whether to provide a compensatory fee to PHAs that choose to self-manage their EPC.
3. Whether the degree of rigor of the EPC application process is necessary to ensure the cost-effectiveness of projects.

The findings from this research helped PD&R understand the strengths and weaknesses, regulatory intent, and general effectiveness of the EPC program. We developed a set of observations to assist HUD in improving the EPC program. Because the study involved a relatively small and therefore unrepresentative sample of PHAs, PD&R may revise these suggestions based on the results of its forthcoming nationwide study of the EPC program, which is intended to provide a more conclusive evaluation and better understanding of the program's value and overall effectiveness. The findings of this initial study clarify the costs incurred and hurdles encountered by participating PHAs in implementing EPCs and will inform a two-phase, more comprehensive, nationwide cost-benefit evaluation of the EPC program that is proposed to begin in FY 2016.

Phase one of the upcoming study would involve a more extensive analysis of PHAs that have EPCs, working with a larger sample of housing authorities with a more representative variation in size, location, installed improvements, and energy conservation incentives deployed. Phase two would focus specifically on very small and small PHAs (fewer than 250 and 500 units, respectively) and on their interest in and efforts at applying for and administering EPCs.

The research team has learned that many very small and small PHAs lack the capability to complete the EPC application process, the volume of potential improvements needed to attract the services of an Energy Service Company (ESCo), and the capability to effectively assess and self-manage an EPC (Board of Trustees of the University of Illinois, 2015). The Department does

[1] http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing/programs/ph/phecc/eperformance.

not presently have the capacity to provide the technical assistance required to boost adoption by very small and small PHAs, nor does it have the resources required to incentivize ESCos to take on projects that may prove to be of higher risk or to yield lower returns.

Both the current project and the proposed follow-on efforts are intended to inform HUD's long-term strategies, in part because the EPC program is being affected by the advent of HUD's Rental Assistance Demonstration (RAD). RAD allows PHAs to leverage public and private debt and equity to reinvest in the public housing stock.

In RAD, public housing units move to a Section 8 platform with a long-term contract that, by law, must be renewed. This renewal clause ensures that the units will remain permanently affordable to low-income households; however, it also removes the units from HUD's public housing inventory and possibly from the EPC funding stream.

If a PHA wishes to convert all or a portion of its EPC-related properties to RAD, it must first determine how it plans to satisfy the existing EPC obligation. Housing authorities have the option of either paying off the EPC debt or assuming the debt and continuing to make the EPC debt payment after conversion to RAD. Regardless of the option chosen, a letter must be submitted to the corresponding field office that formally requests for HUD to end the EPC incentives at the time of conversion and describes how the PHA will address the EPC debt. In instances in which only a portion of a property is converted to RAD, a new baseline utility consumption measurement must be established for the portion of the project that remains in public housing and continues to receive EPC incentives. HUD has recently released a frequently asked questions[2] (FAQ) document that provides additional information related to using an ECP in conjunction with RAD.

History

EPC is an innovative financing technique designed to provide PHAs with cost-effective improvements—energy conservation measures (ECMs)—that are installed with low or no upfront expenditures by the PHA. The costs of the improvements are typically borne by the performance contractor, who is repaid using a portion of the cost savings resulting from the improvements.

As of FY 2015, PIH reports that since the 1980s, when this type of financing technique began,[3] the Department has approved approximately 315 EPCs (affecting approximately 250,000 units), totaling nearly $1.5 billion in investments. EPCs have been executed in all 10 HUD regions[4] and in PHAs ranging from very small (fewer than 250 units) to very large (6,600 units or more). Until now, however, no substantive review of the program's performance has been conducted.

---

[2] http://portal.hud.gov/hudportal/documents/huddoc?id=RAD_EPC_FAQs_030316.pdf.

[3] See http://portal.hud.gov/huddoc/2011EPCInventory.xls and http://portal.hud.gov/hudportal/documents/huddoc?id=EPCInventory2012-2015.xlsx. The "EPC Database: Summary Statistics" spreadsheet contains documentation on EPCs from 1987 through 2011; the "(NEW) EPC Inventory" spreadsheet contains documentation on EPCs executed between 2012 and 2015.

[4] http://portal.hud.gov/hudportal/HUD?src=/localoffices/regions.

Overview of the Program

Section 118(a) of the Housing and Community Development (HCD) Act of 1987 (Oak Ridge National Laboratory, 1992) instituted adjustments to HUD's Performance Funding System (PFS) that enabled PHAs to take advantage of innovative financing techniques (such as energy performance contracting) that are not dependent on additional federal funding. Section 118(a) consisted of two new incentives aimed at encouraging PHAs to reduce utility consumption and a third incentive that favors utility purchase arrangements that reduce the cost of energy consumed. HUD implemented the energy conservation incentives of the HCD Act through revised PFS regulations at 24 CFR 990, which were published as a final rule on September 11, 1991.

Current EPC rules[5] include the following two requirements for funding energy conservation improvements: (1) the ECMs *must* be financed by an entity other than HUD (that is, a private loan); and (2) reasonably anticipated energy savings *must* be sufficient to cover all of the EPC-related debt service that will accrue within 20 years of executing the contract.

In support of these regulations, the Department also issues notices to clarify the EPC-related financial incentives. The Department's most recent EPC notices are hosted on PIH's EPC webpage,[6] which provides resources about all aspects of the EPC program.

Federal Incentives for Funding Energy Conservation in Public Housing

HUD's current EPC program provides PHAs with three incentives: Frozen Rolling Base Incentive (FRB), Add-On Subsidy Incentive (AOS), and Resident-Paid Utility Incentive (RPU). These incentives adjust the federal operating subsidies[7] available to PHAs to enable utility conservation improvements in public housing that reduce utility consumption from baseline levels. The Department also offers the Rate Reduction Incentive (RRI), which can be included in an EPC but can also be used as a separate incentive independent of the EPC program. The RRI allows PHAs to recoup costs of interventions that reduce the *rates* paid for utilities. RRIs may be used in conjunction with the FRB, AOS, or RPU incentives (HUD, 2014). A description of requirements associated with each incentive follows. In total, the incentives are designed to enable PHAs to allocate more of their operating subsidy toward needed repairs and other eligible expenses.

---

[5] *Utilities expense level: Incentives for energy conservation/rate reduction*, 24 CFR 990.185. https://www.gpo.gov/fdsys/pkg/CFR-2011-title24-vol4/pdf/CFR-2011-title24-vol4-sec990-185.pdf.

[6] http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing/programs/ph/phecc/eperformance.

[7] *Operating fund* formula, 24 CFR 990.110. https://www.gpo.gov/fdsys/pkg/CFR-2011-title24-vol4/pdf/CFR-2011-title24-vol4-sec990-110.pdf. Section 9(f) of the United States Housing Act of 1937 establishes an Operating Fund for the purposes of making assistance available to PHAs for the operation and management of public housing. The Operating Fund provides operating subsidy to assist PHAs to serve low-income families. In general, the annual contributions (operating subsidy) that each PHA is eligible to receive is determined by a formula and is based on the difference between formula expenses and formula income.

Frozen Rolling Base Incentive

A PHA may request that the Department freeze its 3-year rolling base utility consumption level (RBCL),[8] used to calculate operating subsidies, at the level of consumption that existed prior to the installation of the EPC improvements. Under the FRB, PHAs may retain 100 percent of the cost savings throughout the term of the contract; they must use at least 75 percent of the annual savings for payment of the EPC loan, however.

Add-On Subsidy Incentive

An add-on (additional operating) subsidy is an increase in the total operating subsidy for a PHA to amortize the costs of EPC improvements and other direct costs of the performance contract. PHAs that use the AOS are limited to receiving the lesser of the project's costs or savings achieved. Any savings associated with overperformance of the installed improvements cannot be retained; such excess savings, however, can be applied to additional improvements (that is, expanding the current project) or used to accelerate debt service on the existing contract.

Resident-Paid Utility Incentive

The RPU allows a PHA to exclude from its Operating Fund rental income calculations, for the duration of the EPC, any increased rental income that results from decreased utility allowances achieved through reduced utility consumption. The change in utility allowances is based on the difference between the baseline and revised allowances of the projects.

Rate Reduction Incentive

If a PHA takes action—beyond normal public participation and effective management in ratemaking proceedings—to reduce its utility cost structure, then HUD will allow the PHA to retain 50 percent of the annual savings. Examples of such PHA actions include purchasing natural gas at the wellhead, making administrative appeals, or taking legal action to reduce its utility rates. Although there are no time limits on the RRI, the incentive is subject to annual review, meaning that the actions taken must continually prove to be innovative and cost effective. Furthermore, the Department has issued recent guidance that expands the RRI incentive to assist housing authorities in capturing the cost savings associated with renewable energy technologies (HUD, 2014).

Key Aspects of an Energy Performance Contract

EPC is a turnkey service that provides customers with a comprehensive set of energy efficiency, renewable energy, and distributed generation measures. Many EPCs are accompanied by guarantees that the savings produced by a project will be sufficient to finance the full cost of

[8] The RBCL is equal to the average of yearly consumption levels for the 36-month period ending on June 30, that is, 18 months prior to the first day of the applicable funding period. A yearly consumption level is the actual amount of each utility consumed during a 12-month period ending June 30. For example, for the funding period January 1, 2015, through December 31, 2015, the RBCL will be the average of three yearly consumption levels: Year 1 = July 1, 2010, through June 30, 2011; Year 2 = July 1, 2011, through June 30, 2012; Year 3 = July 1, 2012, through June 30, 2013.

the project. ESCos are often retained to install and maintain the utility improvements of an EPC. In an EPC, the ESCo can provide the full range of services required to complete the project. These services can include the following.

Energy Audit

An EPC generally requires the activity to begin with an energy audit of the property, which consists of an inspection, a survey, and an analysis of existing energy use in a building or property. The energy audit is the first step in assessing how much energy the building or property consumes and in evaluating what measures can be taken to make it more energy efficient. The audit will establish a baseline against which the savings achieved through performance enhancements may be measured, and will identify any problems that, when corrected, may save significant amounts of energy over time.

Design Engineering

Usually, the next step is preparation of an engineering design by the ESCo that can range from simply specifying energy-efficient lighting and water conservation measures to more complex projects that integrate renewable energy sources (such as solar panels, solar water heaters, or geothermal heat pumps), or that replace or upgrade inefficient heating and cooling equipment.

Construction Management and Commissioning

Once the design is approved, the ESCo provides construction management expertise and helps arrange for long-term project financing. At the end of the construction phase, the ESCo will commission the property by conducting an intensive quality assurance process. The purpose of commissioning is to ensure that the energy upgrades are operating as intended and that building staff are prepared to properly operate and maintain the new systems and equipment.

Operations and Maintenance

After commissioning has been completed, the EPC may require the ESCo to continue providing daily operations and maintenance (O&M) services to augment those performed by building staff. This O&M assistance may be limited to any innovative new technologies (for example, advanced heat pumps or solar panel arrays) that may have been incorporated as a result of the EPC. The parameters of any assistance to be provided by the ESCo should be negotiated at the outset and clearly stipulated in the EPC.

Savings Measurement and Verification

The final major element of a performance contract is the measurement and verification (M&V) process that quantifies the savings attributable to the installed improvements. This element is critical, because the facility owner is depending on the EPC project savings to pay for its financing obligations, and the ESCo is guaranteeing the level of energy savings that will be achieved as a result of its work. As such, the careful design and implementation of M&V protocols serve as the foundation for the long-term success of an EPC project.

A typical EPC project today employs the International Performance Measurement and Verification Protocol (NREL, 2002) to estimate the utility savings that will be achieved through an EPC (ICF International and National Association of Energy Services Companies, 2007). Not every EPC includes all of the elements and activities described previously. The choice of building components, systems, and the responsibilities of all parties to the agreement will reflect the PHA's unique project needs, the skills and capabilities of in-house staff, and available resources. On projects where the performance contract is self-managed, the PHA generally serves as the general contractor and oversees all aspects of the performance contract.

EPC Financing

Arrangement of Long-Term Project Financing

Most EPC projects are financed with long-term debt or leases, though some customers are able to pay a portion of an EPC project with capital budget allocations. In the early days of EPC, ESCos typically provided both project technical services and project financing, as financial institutions rarely understood how EPCs worked and therefore were unwilling to finance them. Some ESCos also acted as product distributors, because many mainstream construction materials and systems distributors were unwilling to stock emerging technology products such as electronic ballasts for compact fluorescent lighting.

Many EPC projects include a guarantee from the ESCo to the customer that projected energy savings will be sufficient to pay the full cost of long-term project financing. The form of the guarantee varies by project, because the guarantees are crafted to suit the requirements of specific customers and federal and state legislation and regulations.

When an EPC has a financing transaction involving a security interest or other encumbrance in public housing property, HUD requires PHAs to obtain written approval for the security interest or encumbrance pursuant to Section 30 of the U.S. Housing Act of 1937 (HUD, 2013).[9] Under some lease-purchase agreements, the ownership of the energy retrofit equipment may reside with the third party, for example, a bank, ESCo, or other entity. When equipment ownership resides with a third party, a Section 30 approval is not required.

Third-Party Financing Marketplace

Almost all EPC projects are financed by third-party finance companies—usually banks and other financial institutions. Major financial institutions like Bank of America, Citibank, GE Capital, and PNC Bank are important funding sources. In addition, specialized EPC project finance brokers (somewhat analogous to mortgage brokers) originate project financing deals and then locate a bank or direct lender to make the loan.

[9] The guidebook provides further information on Section 30 requirements.

Available Capital

Funding appears to be contingent on the size of the project, and larger PHAs have more ready access to funds. A recent study by the University of Illinois found that small and medium PHAs are often unable to attract investors for energy financing at reasonable market rates (Board of Trustees of the University of Illinois, 2015).

Typical Rates and Terms

A typical EPC project is financed directly with the customer (rather than through the ESCo), because many customers can secure better interest rates than those available to the ESCos. The customers generally borrow money to finance the projects, with the ESCo guaranteeing the lender that payments from project savings will be sufficient to cover the finance costs.

HUD'S EPC Approval Process

To participate in the EPC program, PHAs must first determine who will oversee the performance contract. The PHA may elect either to hire an ESCo or to manage the contract itself.

An ESCo can offer a comprehensive range of energy solutions to the PHA, including energy auditing, design engineering, construction management, O&M, and M&V. When the EPC is self-managed, the PHA typically serves as the general contractor, overseeing all aspects of the performance contract and receiving technical support from a third-party consultant.

HUD has developed flow diagrams that outline the steps necessary for application approval under either scenario. In general terms, both approaches require developing and advertising a request for proposal (RFP), conducting an energy audit, developing an EPC contract package, and submitting the contract package for HUD review; the contract is awarded upon receipt of HUD approval. The Department's review process comprises multiple stages—RFP technical review, completeness review checklist, technical review checklist, and panel review—intended to ensure that PHAs are complying with HUD regulations and guidance, and to minimize any risks to the Department. The flow diagrams (under "EPC Process Review") and checklists (under "Checklists") can be found on the PIH EPC webpage.[10]

Under 24 CFR 965.308(b),[11] HUD field offices are the departmental entities that review all EPC solicitations and contract packages. In support of field office review, the Office of Field Operations (OFO) Energy Center was established in circa 2010 to provide quality control (QC) reviews of new contracts and associated savings, quality assurance reviews of existing contracts, and technical assistance to both PHAs and the HUD field offices.

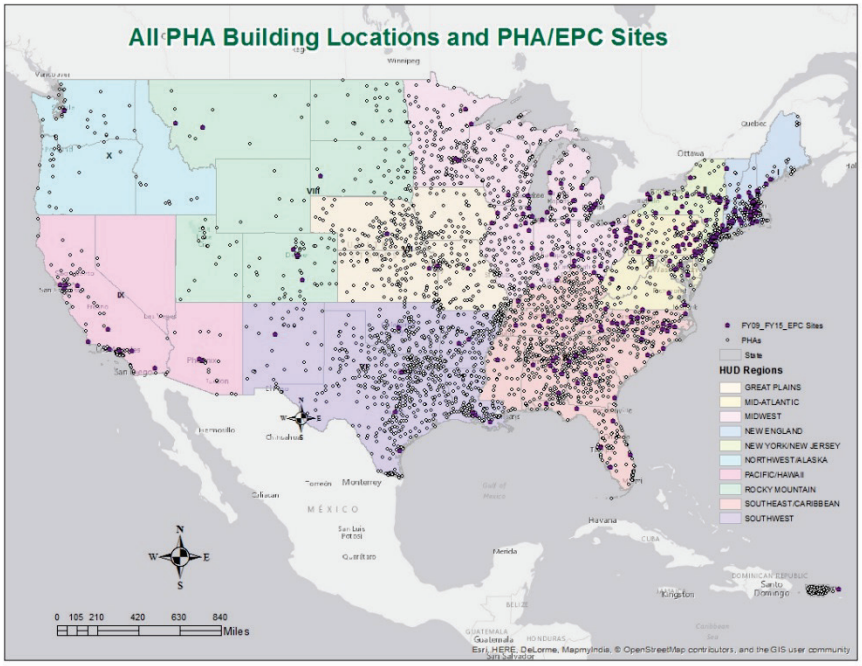
[10] http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing/programs/ph/phecc/eperformance.
[11] https://www.gpo.gov/fdsys/pkg/CFR-2012-title24-vol4/pdf/CFR-2012-title24-vol4-part965-subpartC.pdf.

Methodology

PHA EPC Data Set

Since the inception of EPCs as a financing mechanism for energy retrofits, the Department reports[12] that approximately 315 EPCs (affecting approximately 250,000 units; see Figure 1) have been implemented, resulting in a total investment of nearly $1.5 billion in energy improvements. EPCs have been executed in all 10 HUD regions in PHAs ranging from very small (fewer than 250 units) to very large (6,600 units or more). In addition, PIH maintains spreadsheets[13] that document the EPCs that were executed from 1987 through 2015. These documents contain summary-level EPC information, presented on a fiscal year basis.

Figure 1: Public Housing Authorities (PHAs) in Lower 48 States and Puerto Rico That Have and Have Not Executed an Energy Performance Contract (EPC)



Tables 1 and 2 illustrate the distribution of the Department's EPCs by PHA size category and HUD region. Also displayed are the number of housing authorities in the respective category or region that the Department assists, and the percentage of housing authorities that have executed an EPC relative to the total number of housing authorities of the same PHA size category and HUD region. Because multiple housing authorities have executed additional phases to their initial EPC, EPCs outnumber PHAs that have executed an EPC.

---

[12] See http://portal.hud.gov/huddoc/2011EPCInventory.xls and http://portal.hud.gov/hudportal/documents/huddoc?id=EPCInventory2012-2015.xlsx.
[13] See http://portal.hud.gov/huddoc/2011EPCInventory.xls and http://portal.hud.gov/hudportal/documents/huddoc?id=EPCInventory2012-2015.xlsx.

Table 1 illustrates that the likelihood that a PHA has adopted an EPC varies by the PHA size category. While most PHAs operating low-income public housing are very small and small—fewer than 500 units—(74.3 percent and 14.2 percent, respectively), the EPC adoption rates for these PHAs (1.5 percent and 15.3 percent, respectively) are the lowest among the five size categories. Across all the PHAs, 247 had executed an EPC through FY 2015, for an overall EPC adoption rate of 7.9 percent.

Table 2 similarly shows that EPC adoption rates vary by HUD region. Regions IV, V, VI, VII, VIII, and X have EPC adoption rates below 10 percent, and four of these six regions include 10 percent or more of all PHAs with public housing programs.

Table 1: Distribution of EPCs and PHAs, and EPC Adoption Rate, by PHA Size

PHA Size	EPCs Through FY15	PHAs That Have Executed an EPC	PHAs (Low-Income)	EPC Adoption Rate
	percent (number)	percent (number)	percent (number)	percent
Very small (fewer than 250)	11.7 (37)	14.2 (35)	74.3 (2,318)	1.5
Small (250–499)	24.8 (78)	27.5 (68)	14.2 (444)	15.3
Medium (500–1,249)	27.9 (88)	30.4 (75)	7.1 (221)	33.9
Large (1,250–6,599)	32.1 (101)	25.5 (63)	3.9 (121)	52.1
Very large (6,600+)	3.5 (11)	2.4 (6)	0.4 (14)	42.6
	100.0 (315)	**100.0 (247)**	**100.0 (3,118)**	**7.9**[a]

EPC = Energy Performance Contract. PHA = public housing authority.
[a] The total adoption rate (7.9 percent) is the quotient of the "PHAs that have executed an EPC" and "PHAs (Low-Income)" (247/3,118 = 0.0792).
Note: Due to rounding, not all reported percentages precisely equal 100.0 percent.

Table 2: Distribution of EPCs and PHAs, and EPC Adoption Rate, by HUD Region

HUD Region	EPCs Through FY15	PHAs That Have Executed an EPC	PHAs (Low-Income)	EPC Adoption Rate
	percent (number)	percent (number)	percent (number)	percent
I	16.5 (52)	16.2 (40)	5.4 (169)	23.7
II	14.6 (46)	13.8 (34)	5.3 (165)	20.6
III	17.5 (55)	15.8 (39)	5.5 (173)	22.5
IV	20.3 (64)	21.1 (52)	25.4 (793)	6.6
V	19.0 (60)	19.0 (47)	17.1 (533)	8.8
VI	3.5 (11)	4.0 (10)	22.6 (704)	1.4
VII	1.3 (4)	1.6 (4)	11.1 (346)	1.2
VIII	2.5 (8)	2.8 (7)	3.6 (112)	6.3
IX	4.4 (14)	5.3 (13)	2.2 (68)	19.1
X	0.3 (1)	0.4 (1)	1.8 (55)	1.8
Totals	**100.0 (315)**	**100.0 (247)**	**100.0 (3,118)**	**7.9**[a]

EPC = Energy Performance Contract. HUD = U.S. Department of Housing and Urban Development. PHA = public housing authority.
[a] The total adoption rate (7.9 percent) is the quotient of the "PHAs that have executed an EPC" and "PHAs (Low-Income)" (247/3,118 = 0.0792).
Note: Due to rounding, not all reported percentages precisely equal 100.0 percent.

Tables 3 and 4 illustrate the distribution of units affected by an EPC by PHA size category and HUD region. These tables also display the overall unit count of the PHAs that have executed an EPC, and the percentage of units that have been affected by an EPC relative to the total number of PHA units of the same PHA size category and HUD region.

Table 3: Distribution of EPC and PHA Unit Count, and Affected Unit Rate, by PHA Size

PHA Size	PHA Unit Count (Executed an EPC)	Unit Count (Affected by an EPC)	PHA Unit Count (Low-Income)	Affected Unit Rate
	percent (number)	percent (number)	percent (number)	percent
Very small (fewer than 250)	1.2 (5,858)	2.1 (5,273)	17.1 (204,751)	2.6
Small (250–499)	5.2 (24,960)	8.9 (22,350)	12.9 (153,964)	14.5
Medium (500–1,249)	12.4 (59,736)	21.8 (54,738)	14.1 (168,472)	32.5
Large (1,250–6,599)	32.7 (157,063)	49.4 (123,775)	25.4 (303,911)	40.7
Very large (6,600+)	48.4 (232,232)	17.8 (44,486)	30.4 (363,120)	12.3
	100.0 (479,849)	**100.0 (250,622)**	**100.0 (1,194,218)**	**21.0**[a]

EPC = Energy Performance Contract. PHA = public housing authority.
[a] The total affected unit rate (21.0 percent) is the quotient of the "Unit Count (Affected by an EPC)" and "PHA Count (Low-Income)" (250,622/1,194,218 = 0.2098).
Note: Due to rounding, not all reported percentages precisely equal 100.0 percent.

Table 4: Distribution of EPC and PHA Unit Count, and Affected Unit Rate, by HUD Region

HUD Region	PHA Unit Count (Executed an EPC)	Unit Count (Affected by an EPC)	PHA Unit Count (Low-Income)	Affected Unit Rate
	percent (number)	percent (number)	percent (number)	percent
I	8.6 (41,318)	10.9 (27,343)	6.3 (75,161)	36.4
II	43.8 (209,963)	15.8 (39,478)	21.5 (256,372)	15.4
III	11.0 (52,847)	18.1 (45,271)	10.3 (123,389)	36.7
IV	11.2 (53,548)	18.2 (45,665)	25.2 (301,239)	15.2
V	16.3 (78,314)	21.8 (54,623)	15.5 (184,802)	29.6
VI	2.5 (11,869)	4.6 (11,503)	9.9 (118,331)	9.7
VII	0.7 (3,540)	1.4 (3,526)	3.4 (40,339)	8.7
VIII	1.3 (6,444)	2.1 (5,378)	1.4 (16,750)	32.1
IX	4.0 (19,275)	5.8 (14,537)	4.6 (54,458)	26.7
X	0.6 (2,731)	1.3 (3,298)	2.0 (23,377)	14.1
Totals	**100.0 (479,849)**	**100.0 (250,622)**	**100.0 (1,194,218)**	**21.0**[a]

EPC = Energy Performance Contract. HUD = U.S. Department of Housing and Urban Development. PHA = public housing authority.
[a] The total affected unit rate (21.0 percent) is the quotient of the "Unit Count (Affected by an EPC)" and "PHA Count (Low-Income)" (250,622/1,194,218 = 0.2098).
Note: Due to rounding, not all reported percentages precisely equal 100.0 percent.

Table 3 illustrates that a majority of the units affected by an EPC are, not surprisingly, within the three larger PHA size categories: medium (54,738 units), large (123,775 units), and very large (44,486 units). After controlling for housing authorities that have executed multiple EPCs, it was determined that 250,622 units[14] (244 PHAs) have been affected by an EPC through FY 2015, for an overall affected unit rate of 21.0 percent.

Table 4 similarly shows that the rate of units affected by an EPC varies by HUD region. Regions VI, VII, and X have affected unit rates below 15 percent, and each of these regions contains less than 10 percent of the Department's public housing unit count.

Selection of Participating PHAs

In June 2015 the research team conducted preliminary discussions with a pool of 16 prospective PHAs to determine their willingness and availability to participate in the EPC study. This subset of PHAs was selected from the Department's 2011 EPC data set; the only prerequisite for participation was that the PHA must have completed EPC improvements after 2009. The timing aspect of this prerequisite coincides with establishment of the OFO-Energy Center team, which is based in HUD's Buffalo Field Office and serves as the Department's central point for review and approval of EPCs. Based on conference calls and email communication, the team classified potential study participants into three groups: nine PHAs expressed an interest in participating, four indicated disinterest, and the remaining three were listed as potential alternates.

As illustrated in Table 5, the nine participating PHAs were selected to represent a diverse mix of housing authorities based on factors such as PHA size, complexity of installed improvements, HUD region, EPC dollar amount, and phase of the EPC. Cost-effective travel by the research team was another factor in the selection.[15] A majority of the identified potential PHAs that expressed disinterest or were listed as a potential alternate site indicated either that the units under their existing EPC were being transited to RAD or that a majority of their current staff were not familiar with the executed EPC and how it benefited the housing authority. The team conducted site visits at all nine participating PHAs during August and September 2015.

Due to the pilot's small sample size, and because some PHAs did not wish to participate, the research team recognizes that the conclusions drawn from this effort may be based on an unrepresentative group of PHAs. PD&R's followup study is expected to present a clearer view of the EPC universe.

[14] For PHAs that have executed multiple EPCs (that is, have executed more than one EPC phase), the EPC phase that had the largest number of affected units was retained. If the number of affected units was identical for the multiple phases, then the number of affected units for the most recent EPC phase was retained. If a PHA's number of affected units was missing from the EPC data set, the PHA and its overall unit count were excluded from this analysis.

[15] PD&R staff were granted FY15 travel funds to visit the nine participating housing authorities. The site visits were performed between August and September 2015.

Table 5: Diverse Mix of Participating PHAs

PHA Name	PHA Code	State	PHA Region[a]	PHA Size[b]	Total Units	Units Affected by EPC
Wilmington Housing Authority	DE001	DE	III	large	1,556	1,472
Clinton County Housing Authority	PA040	PA	III	small	457	457
Greenwood Housing Authority	MS107	MS	IV	small	408	408
North Little Rock Housing Authority	AR002	AR	VI	medium	1,042	1,040
Kansas City, Kansas Housing Authority	KS001	KS	VII	large	2,058	2,046
Denver Housing Authority	CO001	CO	VIII	large	3,922	3,379
Housing Authority of the County of Chester	PA046	PA	III	small	331	207
Metropolitan Development and Housing Agency	TN005	TN	IV	large	5,383	4,580
Watervliet Housing Authority	NY025	NY	II	small	307	307

EPC = Energy Performance Contract. PHA = public housing authority.
[a] U.S. Department of Housing and Urban Development, "HUD's Regions," http://portal.hud.gov/hudportal/HUD?src=/localoffices/regions.
[b] Very small (fewer than 250 units); small (250–499 units); medium (500–1,249 units); large (1,250–6,599 units); and very large (6,600+ units).

Of the PHAs that confirmed interest in participating, two (DE001 and CO001) were currently self-managing their EPCs; the remaining seven had hired an ESCo to manage the contracts on their behalf.[16] Four of the PHAs (AR002, KS001, MS107, and PA040) were in the initial phase of the contract, four (CO001, DE001, NY025, and PA046) had executed a second phase, and the remaining housing authority (TN005) had executed a third phase of the term contract.

Questionnaire

Between July and September 2015 the research team administered the study's questionnaire to the participating PHAs. The questionnaire was designed so that only respondents who understood the executed EPC would be able to complete it. The questionnaire covered four topical sections—general EPC-related information, utility conservation and utility savings, developing and self-managing an EPC, and resident-related matters pertaining to the executed EPC.

In conjunction with the EPC-specific documents, the questionnaire also served as a means of examining whether long-term utility savings are being achieved; how the resulting cost savings are being used; the process, time commitment, and workload (from the PHA's perspective) associated with applying to the EPC program; and barriers to greater EPC adoption by PHAs. A copy of the questionnaire is included as appendix A.

The questionnaire was administered over an 8-week period and was sent to participating PHAs via email in either Word or Acrobat format. On average, respondents were given 7 days prior to the research team's site visit to complete and submit the questionnaire. All nine participating PHAs completed and submitted the questionnaire in a timely manner.

[16] Although Watervliet hired an ESCo to manage the second phase of their EPC, the first phase of their EPC was self-managed.

Site Visits Performed

In August and September 2015, the research team made site visits to each of the participating PHAs (see Figure 2). Each visit lasted approximately half a day and consisted of a roundtable discussion with PHA management and staff, followed by a walkthrough (tour and engineering review) of the installed EPC improvements. For research purposes, the team requested and received permission from each participating PHA to record the roundtable meeting discussions. The site visits performed and key details relating to each of the executed performance contracts are described in the following text and in Table 6.

During the roundtable discussions, the PHA's responses to the completed questionnaires were discussed and PHA staff were given an opportunity to speak about their experiences and lessons learned from their participation in the EPC program. All PHA participants were frank in their discussions and provided first-hand insights about what they would have done differently had they elected to complete another phase of their performance contract; they also candidly offered advice for other PHAs that may be interested in applying to the program.

Figure 2: Public Housing Authorities (PHAs) Visited During the Energy Performance Contracting (EPC) Study

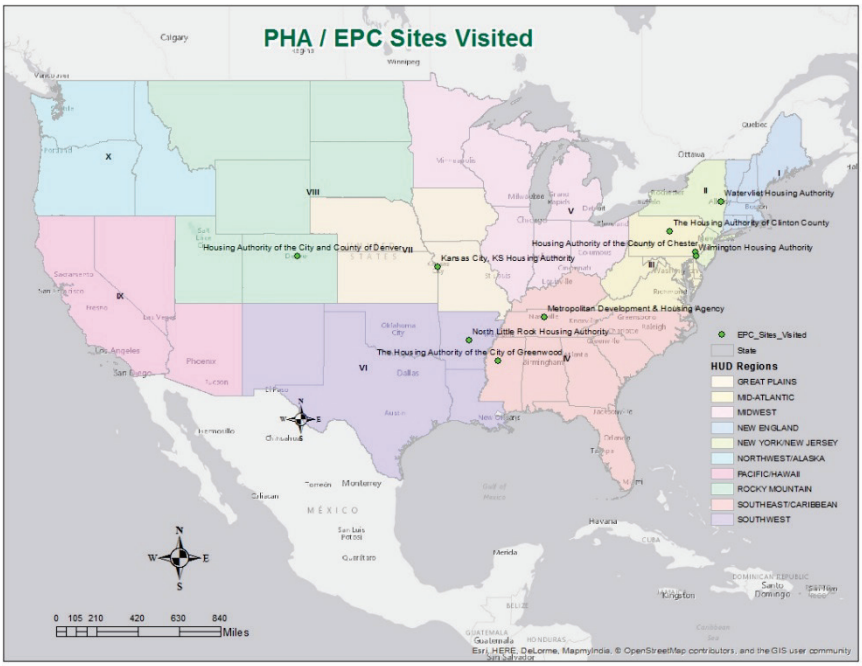


Table 6: Details Related to the Nine Participating PHAs

PHA Name	PHA Code	Type of Improvements	EPC Phase	EPC Term (Years)	EPC Incentives	Contract Costs[a]	1st-Year Estimated Savings
Wilmington Housing Authority[b]	DE001	building envelope, HVAC, water, appliances	2	15	FRB, AOS, RPU	$3,058,724	$662,697
Clinton County Housing Authority[c]	PA040	lighting, water, building envelope, HVAC	1	12	FRB, RPU	$1,127,749	$128,128
Greenwood Housing Authority[d]	MS107	lighting, water, HVAC	1	15	AOS	$3,165,742	$278,706
North Little Rock Housing Authority[e]	AR002	lighting, water, building envelope, HVAC	1	12	AOS, RPU	$3,559,665	$365,273
Kansas City, Kansas Housing Authority[f]	KS001	building envelope, HVAC, lighting, water, appliances renewable energy, miscellaneous	1	20	FRB, AOS, RPU	$16,242,534	$1,030,364
Denver Housing Authority[g]	CO001	lighting, water, HVAC, appliances, building envelope	2	16	AOS	$20,738,802	$2,431,363
Housing Authority of the County of Chester[h]	PA046	lighting, water, building envelope, appliances, HVAC	2	15	FRB	$3,000,000	$407,825
Metropolitan Development and Housing Agency[i]	TN005	building envelope, appliances, lighting, HVAC	3	5	FRB, RPU	$3,079,703	$68,964
Watervliet Housing Authority[j]	NY025	building envelope, HVAC, lighting, appliances	2	15	FRB, RPU	$1,014,851	$88,422

EPC = Energy Performance Contract. PHA = public housing authority.

[a] For the purposes of this analysis, contract costs correspond to the investment costs for the respective EPC Phase.

[b] DE001's Phase 2 EPC is self-managed and extends the existing EPC incentive term from 12 to 20 years. DE001's Phase 1 ESCo was Honeywell, Inc.

[c] PA040's Phase 1 ESCo is Pepco Energy Services.

[d] MS107's Phase 1 ESCo is Siemens Industry, Inc.

[e] AR002's Phase 1 ESCo is Honeywell, Inc.

[f] KS001's Phase 1 ESCo is Johnson Controls.

[g] CO001's Phase 2 EPC is self-managed and extends the existing EPC incentive term from 12 to 20 years. CO001's Phase 1 ESCo was Honeywell, Inc.

[h] PA046's Phase 2 extends the existing EPC incentive term from 15 to 20 years. PA046's Phase 1 and Phase 2 ESCo is Johnson Controls, Inc.

[i] TN005's Phase 3 extends the existing EPC incentive term from 15 to 20 years. TN005's Phase 1, Phase 2, and Phase 3 ESCo is Siemens Industry, Inc.

[j] NY025's Phase 2 extends the existing EPC incentive term from 12 to 15 years. NY025's Phase 2 ESCo is Siemens Industry, Inc.

EPC-Related Data

The OFO-Energy Center team hosts a SharePoint site that contains detailed information on a large number of the EPC projects that the Department has executed. The research team was granted access to this website and gathered contractual information from it on EPC application files, baseline consumption levels, approval documents, and M&V data—all of it pertaining to the performance contracts for each of the participating PHAs. Most of the contractual information was available through the SharePoint site; some data gaps existed, however. In an effort to fill these gaps, the local PIH field office staff (and in some cases the participating PHAs) were asked to obtain any required documentation that was unavailable on the SharePoint site.

Participants in the Field of Energy Performance Contracting

Upon completion of the site visits, the research team contacted a number of internal and external participants in the EPC field. Discussions with these individuals provided a range of perspectives on the EPC program and its application process, and suggested approaches to both improving the EPC program and increasing its adoption rate among members of the PHA community. During each of these discussions, the research team described the purpose of the in-house research project and received feedback on the various participants' experiences with HUD's EPC program.

Discussion

Results of the Questionnaire

Each participating PHA completed a questionnaire about its EPC, its utility savings, the process of developing and managing an EPC, and resident-related matters. The questionnaire consisted of 90 questions and was designed so that, in order to respond appropriately and fully, respondents had to have a working knowledge of their EPC. A summary of the completed questionnaires' major takeaways follows; both aggregate and open-ended responses to all of the questions can be found in appendix B.

EPC Benefits and Savings

Key questionnaire responses suggest that the EPCs for this set of PHAs were a success. **Eight of nine participants stated that their performance contracts were overperforming or performing as projected** (Q35). Similarly, **eight of nine participants responded that they believe their executed EPC was of benefit to their housing authority** (Q55).

When considering their EPC experiences from a counterfactual perspective (that is, what would conditions have been like in the *absence* of the EPC), **eight of nine respondents indicated that only a portion of the improvements installed through the EPC program would have been made** (Q62), and **six of seven respondents believe they would not have been able to achieve the same amount of savings** (Q63).

Use of Excess Savings

From an excess savings perspective, **five of nine respondents reported achieving savings after paying the annual debt service on their executed EPC** (Q38). Respondents were asked to elaborate on how their savings were used. **Four responding PHAs used the savings to pay eligible operating expenses, three specified installing additional improvements by expanding their current EPC, and one used the savings to accelerate payment on its EPC debt** (Q39). Question 39 allowed respondents to make multiple selections.

Level of Effort on Application Process

The team was unable to quantify the level of effort that the participating housing authorities applied to the EPC application process. **Only one of the nine participants responded that it kept a record of the workload (that is, labor hours) associated with applying to the EPC program** (Q58). **The respondent specified that housing authority staff allocated approximately 320–640 labor hours (8–16 weeks) toward the EPC application process** (Q59).

Resident Training and Awareness

The results of the questionnaire illustrate that participating housing authorities were energy conscious to some degree and made efforts to raise residents' awareness of their role in the conservation process. **All nine participants instituted some form of outreach or training program to encourage greater utility conservation among residents** (Q81), and **eight of nine respondents believe that notifying residents of the executed EPC and the resulting building**

upgrades—by posting flyers, distributing PHA newsletters, and holding discussions during resident meetings—**would help residents understand the importance of utility conservation and how their actions can either support or diminish a given project's success** (Q87). **When asked whether these programs resulted in observable changes in residential utility use, two of nine respondents stated that they had observed noticeable changes; the remainder either observed no changes in behavior (three of nine) or indicated that they could not make the determination (four of nine)** (Q88).

A majority of affected residents are not required to pay their own utility bills because they live in buildings that are master metered, which may partly explain the somewhat marginal change in resident behavior. Another contributing factor may be the relatively low resident turnout at the (PHA-provided) outreach and training programs. **Seven of the nine respondents specified that turnout among their respective residents was no higher than 25 percent** (Q86).

With increasing interest on the part of PHAs in promoting energy conservation partly countered by minimal engagement on the part of residents, it may be in HUD's best interests to develop and disseminate resources aimed at energy conservation initiatives that draw on the rapidly developing literature on behavioral economics, with a particular focus on resident behavior modification strategies. Currently, in keeping with EPC regulations and guidance, projected savings from resident behavior modification strategies cannot be considered an EPC, although these strategies can be funded as a supporting project (soft) cost. As a result, any such information dissemination will need to be conducted in parallel to the EPC program. Supporting this premise, **the questionnaire found that eight of nine respondents would be willing to take part in a future HUD research effort to identify viable strategies for promoting resident involvement in utility conservation** (Q90).

Analysis of Measurement and Verification, Utilities Expense Level Data, and HUD Assessment Data

In an effort to quantify the utility consumption savings associated with the study's EPCs, the research team sought to gather and analyze M&V, utilities expense level (UEL), and HUD assessment data for each of the participating PHAs. M&V data document the installed improvements' quantified savings based on the contractual agreements between the PHA and the ESCo or energy consultant, and are provided annually in accordance with each EPC's unique schedule. UEL data (HUD administrative data) are self-reported by PHAs, and are recorded and submitted in accordance with HUD guidelines (that is, on a July 1 to June 30 basis). HUD assessment data document the achieved EPC savings and factors used by the Department to verify the savings as provided by agreements between the PHA and HUD.

Although the research team experienced difficulties with incomplete M&V datasets and did not find any HUD assessment data, an analysis was performed on the participating PHAs' UEL data;

annual development-level consumption quantities from Funding Years 2005–2015[17] (actual consumption spanning July 1, 2003 to June 30, 2014). The UEL data sets for each of the study's participating PHAs can be found in appendix C.

Normalizing Utility Consumption Data

When analyzing consumption data, the research team is cognizant that it is common practice to normalize the data in order to remove any variations associated with weather and building-occupancy conditions. Normalization allows a building's performance to be compared against itself under normal operating conditions. Weather normalizing is typically based on daily or monthly measurements, while occupancy normalizing is generally analyzed from a monthly perspective.

For this study, neither of these normalizing approaches was performed. With the UEL data collected only on an annual basis, plausible correlations with respect to annual heating degree-day (HDD) and cooling degree-day (CDD) measurements were not observed. In addition, the research team assumed that the participating PHAs' occupancy patterns were similar over the analyzed Funding Years.

Methodology and Limitations

The research team's approach toward analyzing the UEL data consisted of comparing the average consumption quantities of before and after the respective EPC phase was executed. This approach was chosen because (1) the UEL data sets consist of EPC and non-EPC related consumption quantities, and (2) each performance contract consists of a unique start date, which increases the likelihood that the reporting periods for a majority of the PHAs' EPC incentives do not align with the UEL reporting cycle. Thus, with all of this taken into consideration, the research team's intent is to provide a general analysis describing the effectiveness of the executed EPCs.

Average Percentage Change Estimates

Tables 8, 9, and 10 illustrate, for each applicable utility type, the average percentage savings observed after each PHAs' first, second, and third EPC, respectively (if applicable). As previously mentioned in this report, four of the PHAs (AR002, KS001, MS107, and PA040) were in the initial phase of their performance contract, four (CO001, DE001, NY025, and PA046) had executed a second phase, and the remaining housing authority (TN005) had executed a third phase. In addition, Table 7 has been included to provide context regarding each PHA's average percentage change, for applicable utility types, relative to their Funding Year 2005 UEL measurements.

[17] Each Funding Year consists of 12 months of utility consumption data, starting 18 months prior to the beginning of the respective Funding Year. For example, Funding Year 2005 consists of consumption data from July 1, 2003–June 30, 2004.

Table 7: Average Percentage Change Relative to Funding Year 2005 Consumption Quantities

PHA	Electricity	Natural Gas	Sewer/Water	Sewer	Water
PA046	20.95%	-3.28%	17.09%	N/A	N/A
TN005	-11.75%	-6.94%	-39.65%	N/A	N/A
KS001	-0.85%	-8.34%	N/A	-1.98%	-8.04%
NY025[a]	0.06%	-23.28%	--------	N/A	N/A
CO001	-33.77%	-40.77%	-32.59%	N/A	N/A
PA040	5.66%	-10.21%	N/A	-9.40%	-9.48%
DE001	-14.45%	-38.16%	-37.08%	N/A	N/A
MS107[b]	-40.81%	-47.05%	--------	N/A	N/A
AR002	0.21%	-31.29%	-12.08%	N/A	N/A

[a] The UEL data sets do not contain any measurements for NY025's owner-paid sewer and water utility.
[b] The UEL data sets do not contain any measurements for MS107's owner-paid sewer and water utility.

The research team is cognizant that this analytical approach is not ideal and does not provide an accurate depiction of the value or savings associated with the installed EPC improvements. However, considering that the UEL data sets are administrative data and the only consistently available resource for utility consumption analysis, the research team believes that the chosen approach is defensible. For the purposes of this study, the Funding Year in which the incentives for each PHAs' EPC were initially observed mark the beginning of the post-EPC consumption period and span through Funding Year 2015. Similarly, all years prior to the Funding Year in which the incentives were initially observed mark the end of the pre-EPC consumption period and span back to Funding Year 2005.

Table 8 displays that seven of nine PHAs observed average percentage decreases across all of their reported utilities after their first executed EPC, which positively illustrates reductions in consumption for a majority of the study's participating PHAs. The two remaining PHAs were TN005 and MS107. TN005 executed its first EPC in Funding Year 1998; however, UEL data sets were not available until Funding Year 2005. MS107 observed an average percentage increase in utility consumption since executing its first EPC; however, from a positive perspective, Table 7 illustrates that the housing authority has observed an overall average percentage decrease relative to its Funding Year 2005 UEL quantities.

Relative to the PHAs' second EPC, Table 9 illustrates that all five PHAs in this subgroup observed average percentage decreases for at least one of their utilities. On a further positive note, Table 9 reveals that two of the PHAs (PA046 and DE001) observed average percentage decreases for two of their utilities, while the remaining two PHAs (CO001 and TN005) observed average percentage decreases for all of their utilities.

Table 10 illustrates that the only PHA to have executed a third EPC (TN005) observed an average percentage decrease in utility consumption for all of its reported utilities.

Table 8: Average Percentage Change Relative to First EPC

PHA	Electricity	Natural Gas	Sewer/Water	Sewer	Water	Funding Year in Which Incentives Were Initially Observed
PA046	-6.09%	-38.62%	-5.82%	N/A	N/A	2010
TN005	N/A	N/A	N/A	N/A	N/A	1998
KS001	-0.68%	-11.85%	N/A	-7.98%	-12.52%	2012
NY025[a]	-2.57%	-24.37%	--------	N/A	N/A	2008
CO001	-40.16%	-56.70%	-42.38%	N/A	N/A	2008
PA040	-2.05%	-12.70%	N/A	-41.31%	-41.03%	2013
DE001	-17.24%	-43.57%	-24.20%	N/A	N/A	2009
MS107[b]	45.58%	55.92%	--------	N/A	N/A	2011
AR002	-2.84%	-44.87%	-26.76%	N/A	N/A	2009

[a] The UEL data sets do not contain any measurements for NY025's owner-paid sewer and water utility.
[b] The UEL data sets do not contain any measurements for MS107's owner-paid sewer and water utility.

Table 9: Average Percentage Change Relative to Second EPC

PHA	Electricity	Natural Gas	Sewer/Water	Sewer	Water	Funding Year in Which Incentives Were Initially Observed
PA046	13.95%	-43.56%	-28.92%	N/A	N/A	2015
TN005	-9.83%	-5.70%	-33.57%	N/A	N/A	2009
KS001	N/A	N/A	N/A	N/A	N/A	N/A
NY025[a]	4.47%	-34.20%	--------	N/A	N/A	2011
CO001	-35.32%	-50.47%	-34.00%	N/A	N/A	2012
PA040	N/A	N/A	N/A	N/A	N/A	N/A
DE001	23.40%	-12.76%	-7.88%	N/A	N/A	2015
MS107	N/A	N/A	N/A	N/A	N/A	N/A
AR002	N/A	N/A	N/A	N/A	N/A	N/A

[a] The UEL data sets do not contain any measurements for NY025's owner-paid sewer and water utility.

Table 10: Average Percentage Change Relative to Third EPC

PHA	Electricity	Natural Gas	Sewer/Water	Sewer	Water	Funding Year in Which Incentives Were Initially Observed
PA046	N/A	N/A	N/A	N/A	N/A	N/A
TN005	-13.02%	-11.36%	-46.44%	N/A	N/A	2013
KS001	N/A	N/A	N/A	N/A	N/A	N/A
NY025	N/A	N/A	N/A	N/A	N/A	N/A
CO001	N/A	N/A	N/A	N/A	N/A	N/A
PA040	N/A	N/A	N/A	N/A	N/A	N/A
DE001	N/A	N/A	N/A	N/A	N/A	N/A
MS107	N/A	N/A	N/A	N/A	N/A	N/A
AR002	N/A	N/A	N/A	N/A	N/A	N/A

Example Calculation

To illustrate the procedure that was followed, the research team offers the following example. The Kansas City Housing Authority (KS001) began observing its EPC incentives in Funding Year 2012. KS001's pre-EPC consumption period consisted of consumption from Funding Years 2005–2011; having averages of 10,813,312 kWh (electricity), 25,457,333 kWh (natural gas), 69,739,780 gal. (sewer), and 77,734,938 gal. (water). While the post-EPC consumption period spanned from Funding Years 2013–2015; having averages of 10,739,763 kWh (electricity), 22,440,725 kWh (natural gas), 64,171,668 gal. (sewer), and 68,000,867 gal. (water).

Therefore, by KS001's average percentage changes for its utilities are:

Electricity: $\frac{(10{,}739{,}763-10{,}813{,}312)}{10{,}813{,}312} \times 100\% = -0.68\%$

Natural Gas: $\frac{(22{,}440{,}725-25{,}457{,}333)}{25{,}457{,}333} \times 100\% = -11.85\%$

Sewer: $\frac{(64{,}171{,}668-69{,}739{,}780)}{69{,}739{,}780} \times 100\% = -7.98\%$

Water: $\frac{(68{,}000{,}867-77{,}734{,}938)}{77{,}734{,}938} \times 100\% = -12.52\%$

By averaging each PHA's utility consumption quantities from before and after their executed EPCs, the research team is able to provide rough estimates regarding the effectiveness of the EPCs.

Public Housing Policy Inquiries

At the outset of this project, PIH requested that we explore three policy-related issues that could be informed by the study:

1. Whether to allow PHAs to use utility savings from EPCs for non-energy-related or non-water-related capital improvements.
2. Whether to provide a compensatory fee to PHAs that choose to self-manage their EPC.
3. Whether the degree of rigor of the EPC application process is necessary to ensure the cost-effectiveness of projects.

To address these considerations, the research team incorporated relevant content in the questionnaire. The following discussion describes feedback derived from the questionnaire and observations proposed by the research team. However, since these observations were based on a relatively small and therefore unrepresentative sample of PHAs, PD&R may revise these observations based on the results of its larger, nationwide study of the EPC program.

Apply EPC Utility Savings Toward Non-Energy-Related and Non-Water-Related Capital Improvements

The questionnaire asked participants if their housing authority would benefit if HUD allowed achieved utility savings from EPCs to be applied toward non-energy-related and non-water-related capital improvements.

Current PIH guidance specifies that any savings generated by the installed EPC improvements and retained by the PHA may be used to pay for—[18]

1. Any eligible operating expense.
2. EPC debt service on other projects under the same EPC contract.
3. Additional energy-efficient or green building improvements that can be achieved by expanding the current project.
4. The acceleration of debt service on the existing project, if permitted under the financing contract.

Six of eight respondents believed that allowing excess EPC savings to be applied toward capital improvements would be beneficial. One respondent did not believe that such change would help, and the remaining respondent indicated that it was not sure (Q40). **One of the study's nine participants did not respond to this question.**

In terms of providing maximum flexibility for grantees and providing incentives for the further adoption of EPCs at additional PHAs, the research team views as compelling the favorable response by a majority of respondents to the question about allowing EPC savings to be applied toward capital improvements.

> ***Observation*:** Allow EPC savings for capital needs and provide guidance on incorporating a contingency reserve into a project's total costs.

Based on the findings in this report, we recommend that HUD should consider whether the four existing EPC categories of eligible uses can be expanded to allow for savings generated to be used for capital improvements. This fifth category of eligible use would allow for greater flexibility for participating PHAs and provide additional incentives for additional PHAs to consider entering into new EPC arrangements. We would also recommend that if HUD determines it lacks the authority to make this change based on existing statutory requirements, then HUD should consider proposing such a change to Congress. Such an observation could be included in an annual budget request.

One constraint identified by some respondents is the requirement that the EPC's anticipated savings need only be sufficient to *reasonably* cover all of the debt service within 20 years of executing the contract. Such a stipulation implies that for an EPC, in some circumstances the achieved savings will not be enough to cover the debt service, in which case a housing authority might have to use additional Operating Fund resources to make up the difference.

Such a situation may also occur as a result of a lower than expected Operating Fund allocation, for instance in the event of a proration. Each fiscal year, Congress has the authority to appropriate a percentage of the requested funding level that HUD submits in support of the funds needed to operate and maintain the nation's public housing stock. Since FY 2005, the

[18] The only exception to this specification is when the term of the EPC contract is complete and the PHA requests a regulation waiver to use excess EPC cost savings for purposes other than eligible Operating Fund expenses.

average Operating Fund subsidy has only been 90 percent,[19] which forces housing authorities to alter their operations and prioritize the services and maintenance they provide and the staff they employ. Such funding levels may create a dilemma for PHAs in which the funds are insufficient to service the EPC debt while physically maintaining public housing properties. To guard against this potential appropriations risk, the research team recommends that future HUD guidance should emphasize the benefit of incorporating a contingency reserve into the project's total costs. Such a reserve could be used to cover EPC debt service in the event of a reduced appropriation. Such a provision might be an important incentive for smaller PHAs that have a low margin for error in a limited annual Operating Fund environment.

Provide a Compensatory Fee to PHAs That Self-Manage an EPC

Participants also were asked whether a PHA that chooses to self-manage an EPC should be compensated for this effort.

Six of nine respondents specified that they do believe that a PHA should be compensated for the effort of self-managing an EPC; the other three respondents indicated that they do not believe compensation should be provided for such actions (Q51).

In addition to the complexities associated with applying to the EPC program, self-managing an EPC requires the housing authority to serve as general contractor, which can be complex and cumbersome regardless of the type of improvements that are installed. Self-managing PHAs must take on the additional burden of coordinating and overseeing all of the work performed by their subcontractors.

***Observation*:** Allow compensatory incentives.

Considering the challenges of meeting the additional requirements of self-managing an EPC, the research team believes that instead of being provided a compensatory fee, this subgroup of PHAs should be compensated for their efforts by being provided greater flexibility in how a project's resultant cost savings may be used. Such flexibility may include broadening the ways in which the cost savings may be used[20] or decreasing the required percentage of annual cost savings paid toward EPC debt services (HUD, 2011).[21]

PD&R is cognizant that the initial intent of this policy-related issue was to inquire about whether to provide PHAs a compensatory fee for EPC self-management. However, after careful consideration, the research team is hesitant to recommend a fee that will take away from the bottom-line dollar amount that PHAs can use toward financing improvements and other project-related expenses.

---

[19] On December 23, 2015, HUD's Real Estate Assessment Center provided a historical proration table (1981–2015) of the Public Housing Operating Fund.

[20] As described earlier in the report, any savings generated by the installed improvements may be used to pay for: (1) eligible operating expenses, (2) EPC debt service on other projects under the same EPC contract, (3) additional energy-efficiency or green building improvements, or (4) accelerating the debt service of the existing project.

[21] PIH guidance specifies that 75 percent of the annual utility savings must be utilized toward the payment of EPC project costs. In cases in which less than 75 percent of the savings is used for debt service, HUD will retain the amount of the difference by reducing the project's subsidy by that amount.

Providing such incentives would likely encourage more PHAs to self-manage their EPCs, which will promote greater oversight and overall efficiency of the funded project because the participating housing authorities would be more vested in the executed contracts and an innovative Department incentive aimed at reducing the public housing portfolio's utility consumption would be illustrated.

Is the Rigor of the Application Process Necessary To Ensure a Cost-Effective Project?

Participants were asked if they thought that the rigor of the EPC application process was necessary for HUD to ensure the cost-effectiveness of the project.

Seven of nine respondents indicated their belief that the present degree of rigor on HUD's part is necessary to ensure the cost-effectiveness of a given project is (Q60).

The research team finds this viewpoint to be well founded, given the large sums of money involved,[22] the technical documentation that must be submitted, and the risks inherent in complex EPC agreements. As previously stated, process flow diagrams (under "EPC Process Review" on the PIH EPC webpage)[23] have been developed that outline the multiple steps that PHA applicants and HUD must complete before an application can receive approval.

***Observation*:** Maintain the rigor of the EPC application requirements.

The research team has observed that thorough application reviews are key in the success of the EPC program, and that these reviews benefit both the PHAs and HUD. Therefore, this report recommends maintaining the rigor of the current application process requirements, as the benefits outweigh the costs of complying with those requirements.

The team observed a data limitation that affects the measurement of how rigorous the EPC review efforts are, however. The ideal approach to analyzing applications would assess approval times relative to achieved savings. As described in more detail in the "Observations" section that follows, data on achieved savings are not currently collected. Data on achieved savings could support a new evidence-based metric on cost-effectiveness of review efforts. This limitation and an observation to address it are discussed in the following section.

[22] Of the 315 EPCs listed within the PIH Excel data sets, 294 had a plausible "Total Cost of EPC Project" quantity. The research team found that the EPC project costs ranged from $63,400,000 to $38,000, wherein the average EPC Project Cost was $4,800,000.

[23] http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing/programs/ph/phecc/eperformance.

Summary

The goal of this pilot study was to conduct an initial inquiry into the value and effectiveness of PIH's EPC program to inform a more comprehensive nationwide study of the use of energy performance contracts by PHAs. EPCs are a regulatory tool providing flexible financing options for PHAs to use resultant utility cost savings to fund utility-related capital improvements. By providing enhanced financial flexibility to PHAs, EPCs encourage them to make more strategic and comprehensive utility upgrades than they could undertake with limited capital funds.

As HUD administers the EPC program to promote long-term benefits, a core aspect is ensuring regulatory compliance and minimizing risks to the Department and taxpayers. A successful EPC program will reduce utility consumption within the federally assisted housing stock, ease the financial burden on taxpayers, alleviate negative impacts on the environment, and create green jobs.

The study's survey demonstrated that the EPCs for this set of PHAs were a success. The following findings support this contention—

- Eight of nine respondents stated that their performance contract was of benefit to their housing authority (Q55).
- Eight of nine respondents indicated that only a portion of installed improvements would have been made without the flexibility provided by the EPC program (Q62).
- Five of nine respondents noted having achieved cost savings after paying the annual debt services on their EPC (Q38).
- Eight of nine respondents stated that their executed performance contract was either overperforming or performing as projected (Q35).
- Six of seven respondents believe they would not have been able to achieve the same amount of savings in the absence of the EPC (Q63).
- Six of eight respondents believe that allowing excess EPC savings to be applied toward capital improvements would be beneficial (Q40).
- Six of nine respondents believe that a PHA should be compensated for the effort of self-managing an EPC (Q51).
- Seven of nine respondents believe that rigorous review on HUD's part is necessary to ensure the cost-effectiveness of projects (Q60).

Observations Supporting EPC Program Objectives

The preceding section summarized the research team's findings and observations related to the three policy questions posed by PIH. In the following section the team offers five additional observations on the basis of this research. However, because these observations were based on a relatively small and therefore unrepresentative sample of PHAs, PD&R may revise these observations based on the results of its larger, nationwide study of the EPC program.

In proposing these observations, the research team kept these four EPC program objectives in mind—

1. Reducing the approval time of an EPC application.
2. Providing more transparency in the Department's application review efforts.
3. Providing PHAs with further guidance on the collaborative use of an EPC and RAD.
4. Providing more transparency in the realized savings of an EPC.

Objective: Reducing the Approval Time of an EPC Application

***Observation*:** Develop a PHA-EPC working group.

Establish a PHA-EPC working group to allow PHAs that have executed an EPC to serve as champions of the EPC program and as mentors to housing authorities that are new to the EPC application process. Such a working group would serve as a peer-review mechanism that can be beneficial to the Department and participating housing authorities by establishing a cost-effective strategy to promote the EPC program and provide assistance and guidance from a more hands-on perspective, and to reduce the overall burden placed on HUD staff during application review.

As noted previously, results from the questionnaire indicate that, from a utility performance perspective, eight of nine participants had executed an EPC that was performing as projected or above the initial estimated savings projections (Q35). In addition, five of the nine participants had executed at least a second phase of their existing EPC. Taken together, these results indicate that the program is of value from a utility performance perspective, and that many of the participating PHAs can be considered well versed in the intricacies of the application process.

Considering that only approximately 10 percent of the public housing stock (approximately 20 percent of the overall public housing unit count) has been covered by an EPC since the program's inception, an important opportunity lies in leveraging the first-hand knowledge and experiences of participating PHAs to strengthen the EPC program by establishing a working group. Such a collaborative approach would entail ongoing, reciprocal communication among the PHAs and HUD's EPC staff, and would likely encourage more housing authorities to inquire about and apply to the program. Gaining active support among members of the PHA community would also be likely to encourage buy-in from the representative trade groups that advocate for the PHA community—primarily the Public Housing Authorities Directors Association (PHADA), National Association of Housing and Redevelopment Officials (NAHRO), and Council of Large Public Housing Authorities (CLPHA).

Such a working group could also prove beneficial in light of the limited programmatic resources currently available to housing authorities in the EPC application process. During the site visits and interviews with subject matter experts, the research team observed that a significant programmatic hurdle encountered by many participants is the time required to receive EPC approval. The research team is aware that the application process is highly complex, given the number of factors that must be taken into account. In analyzing the approval times for the participating PHAs, the team found that for seven of the nine housing authorities, the average approval time took 250 calendar days[24] (roughly 8 months) and included the time in which PHAs or ESCos made revisions to the applications.

By instituting a peer-review mechanism for PHAs that are new to the EPC application process, the potential exists to substantially reduce the amount of time the Department spends in assuring that all required application forms are appropriately submitted. This in turn would allow the Department to focus its resources toward reviewing the technical aspects of an EPC application and to providing more detailed technical support and guidance when necessary.

Objective: Providing Greater Transparency in the Department's Application Review Efforts

***Observation*:** Revise the duration metric of the EPC application approval time.

For this effort, the research team measured the overall approval time for an EPC application from the date when the application package was received to the date when the corresponding EPC approval letter was sent to the subject PHA. For the study's nine participating PHAs, the average approval time was 250 calendar days[24] (approximately 8 months) and included the time in which PHAs or ESCos made revisions to the applications. Within the past 3 years, the Department has further refined this metric to account separately for the time HUD is reviewing the application and the time the PHA is revising the application. Although it is logical for accounting purposes to measure how long the Department has the EPC application and how long the PHA has it, this approach doesn't fully take into account the level of effort the Department expends in reviewing the application. The research team recommends supplementing the approval time metric with a metric and additional discussion that captures the Department's review efforts related to an approved EPC's total project costs.

Results from the questionnaire indicate that seven of nine respondents believed the rigor associated with the application process was necessary to make sure that the EPC was cost-

[24] For the purposes of this analysis, the approval times were calculated as the difference between the dates listed in the "Package Received" and "Date FO sent Approval/Disapproval to PHA" columns of the Contract_Status_Database.xlsx spreadsheet. These dates were chosen to illustrate the *overall* time that it takes for an EPC application package to receive approval, including the time in which PHAs or ESCos made revisions to the applications. The spreadsheet did not contain any information pertaining to the North Little Rock Housing Authority (AR002), and the Housing Authority of the County of Chester (PA046) did not have a date listed in the "Date FO sent Approval/Disapproval to PHA" column. In total, the spreadsheet listed 133 EPCs on its "ESA" (Energy Service Agreement) tab, wherein 72 of the entities had plausible "Package Received" and "Date FO sent Approval/Disapproval to PHA" dates. For these 72 entities, the research team found that the approval times ranged from 9 to 1,013 calendar days, wherein the average approval time was 193 calendar days (roughly 6 months).

effective (Q60). The research team believes that this viewpoint is well founded, considering the large sums of money involved[25] and the risks inherent in complex EPC contractual agreements. For an EPC, the PHA is held accountable for the total project costs of the contract: debt service payments, M&V fees, and equipment replacement costs.

As previously mentioned, the Department conducts multiple stages of review during the EPC application process to ensure compliance with HUD regulations and guidance and to minimize risk to the Department. During these review periods, HUD may require adjustments to the PHA applicant's cost and saving estimates, which in turn have an effect, either directly or indirectly, on the total project costs for which the housing authority will be held accountable.

To account for the level of effort the Department invests in reviewing each application to ensure cost-effectiveness, minimize associated risks, and ensure adherence to HUD regulations and guidance, PIH should supplement the approval time metric to take into account changes in total project costs relative to the proposed EPC, as well as the overall duration of the application process.[26] Instituting a policy that employs such metrics would assist PIH in justifying (and being more transparent about) the duration and level of effort involved in the EPC application review process.

Objective: Providing Further Guidance on the Collaborative Use of an EPC and RAD

> ***Observation*:** Develop a decision logic tree in support of using an EPC in conjunction with RAD.

HUD recently released a FAQ[27] document that describes the use of an EPC in conjunction with RAD. RAD allows PHAs to leverage public and private debt and equity in order to reinvest in the public housing stock. Through RAD, units move to a Section 8 platform with a long-term contract that, by law, must be renewed periodically. This renewal clause ensures that the units remain permanently affordable to low-income households, thus removing the units from HUD's public housing inventory and possibly from the EPC funding stream.

As previously mentioned, if a PHA wishes to convert all or a portion of its EPC-related properties to RAD, it must first determine how it plans to satisfy the existing EPC obligation. Housing authorities have the option of either paying off the EPC debt or assuming the debt and continuing to make the EPC debt payment after conversion to

---

[25] Of the 315 EPCs listed within the PIH Excel data sets, 294 had a plausible "Total Cost of EPC Project" quantity. The research team found that the EPC project costs ranged from $63,400,000 to $38,000, wherein the average EPC Project Cost was $4,800,000.

[26] For example, a PHA submitted, on April 1, an EPC application that spanned 12 years and consisted of $100,000 in total project costs. During the PIH review process, it is determined that incorrect utility rates were used to estimate the installed improvement's projected savings, resulting in a decrease in total project costs by $5,000. As a result, the application is approved on August 15 and consists of a total project costs amount of $95,000. The Revised Duration Metric would consist of an approval time of 136 calendar days (~ 4.5 months) and a change in total project costs of -$5,000 (5 percent decrease in total project costs).

[27] http://portal.hud.gov/hudportal/documents/huddoc?id=RAD_EPC_FAQs_030316.pdf.

RAD. In instances such as this, PHAs must notify the Field Office of their intent and establish a new baseline utility consumption measurement for the portion of the project that remains in public housing and continues to receive EPC incentives.

The research team is hopeful that the FAQ document will be well received by the PHA community, because several PHAs that participated in the study stated that they did not clearly understand whether a RAD conversion would benefit them. In addition, during preliminary discussions with potential study participants, several of the non-selected PHAs declined or were hesitant to participate in this study because they were considering a RAD conversion. Given both the complexities and the level of effort that PHA and HUD staff invest in preparing and approving an EPC application, the research team recommends that the FAQ document be expanded to include a logic-based decision tree (similar to the flow diagrams necessary for application approval) that will assist PHAs in working through the decisions that should be taken into account when considering a conversion of EPC-related PHA units (Section 9) to RAD units (Section 8).

Objective: Providing More Transparency in the Realized Savings of an EPC

***Observation*:** Annually update cash flow spreadsheets.

A PHA's finalized cash flow spreadsheet for an EPC establishes benchmarks in the form of annual costs and savings that can be expected to accrue on the PHA's behalf. Embedded within these projections are critical assumptions about factors that are beyond the PHA's control and that can affect actual cost savings.

Examples of critical assumptions include the escalation rates associated with future energy savings and the annual maintenance costs of replacement equipment. A typical assumption for electrical service rates is that the rates will increase 3 percent per year. In many localities these rates are not fixed and may periodically observe either reductions or modest increases over the course of the performance contract. Similarly, the replacement costs for EPC-installed equipment are generally correlated to the equipment's useful life expectancy and scheduled maintenance intervals. As a performance contract unfolds, multiple factors may cause this equipment to be replaced more frequently than projected in the life expectancy developed by the manufacturer. Due to actual versus projected energy savings and maintenance costs, the PHA that has executed the EPC may retain smaller annual excess cash-flow amounts than those initially projected.

To assist both the Department and the PHAs in evaluating the performance of EPCs, the research team recommends that PIH should require annually updating the spreadsheets' projected costs and savings with realized quantities. Instituting such a policy would substantiate the EPC program's inherent benefits and would provide a valuable comparison of the performance contract's projected and actual savings.

***Observation*:** Align the reporting periods of the annual M&V reports with annual UEL quantities.

HUD's EPC guidance requires PHAs to submit annual M&V reports to HUD field offices for reconciliation of estimated savings amounts. The submitted reports display the annual consumption and cost quantities, typically on a monthly basis, for the project's affected properties. The reporting periods for the respective reports are dependent on the completion of the installed EPC improvements and may not coincide with HUD's UEL reporting period of July 1 to June 30.

While analyzing the submitted M&V reports, the research team consistently encountered difficulties in verifying reported savings quantities relative to annual UEL quantities submitted by the PHAs. During site visits, several PHAs noted this same difficulty.

The research team recommends requiring that the reporting periods for the submitted annual M&V reports align with the annual cycle in which PHAs report UEL quantities (July 1 to June 30); in this way the proposed EPC savings can be verified. PD&R is cognizant of the different reporting periods for the varying EPC incentives (July 1 to June 30 for the FRB and RPU incentives and January 1 to December 31 for the AOS incentive) but believes that a uniform M&V reporting period will be beneficial to the EPC program.

Key benefits stemming from such an approach would include creating greater transparency in the savings reported by the serving ESCo or third-party consultant while providing an additional QC measure for the submitted M&V reports. For PHAs that receive the AOS incentive, the research team does not believe that it will be too burdensome for the servicing ESCo or third-party consultant to approximate or combine savings quantities from adjacent AOS reporting periods.

Conclusion

Even with a small sample of PHAs, the pilot research described in this report provided numerous observations about the relative strengths and weaknesses, regulatory intent, and general effectiveness of the EPC program. The responses and viewpoints of the participating public housing staff were central to the development of the study's major observations. Although participating PHAs were fairly diverse in size and location, they are in no way representative of all PHAs. PD&R's followup study of the EPC program will be a more representative, nationwide effort intended to provide a more complete picture, definitive understanding, and comprehensive evaluation of the EPC program.

References

Board of Trustees of the University of Illinois. 2015. Applied Research Demonstration To Test Self-Managed Energy Performance Contracting for Small to Medium Size Public Housing Authorities. Unpublished paper. Champaign, IL: Office of Sponsored Programs and Research Administration. Unpublished paper.

ICF International and National Association of Energy Services Companies. 2007. *Introduction to Energy Performance Contracting*. Washington, DC: U.S. Environmental Protection Agency. https://www.energystar.gov/ia/partners/spp_res/Introduction_to_Performance_Contracting.pdf.

National Renewable Energy Laboratory. 2002. *International Performance Measurement & Verification Protocol: Concepts and Options for Determining Energy and Water Savings, Volume I*. Washington, DC: U.S. Department of Energy. http://www.nrel.gov/docs/fy02osti/31505.pdf.

Oak Ridge National Laboratory. 1992. *Energy Performance Contracting for Public and Indian Housing: A Guide for Participants*. Washington, DC: U.S. Department of Energy; U.S. Department of Housing and Urban Development. http://www.huduser.gov/portal/Publications/pdf/energy.pdf.

U.S. Department of Housing and Urban Development (HUD). 2013. *Energy Performance Contract Section 30 Reviews and Approvals Guidebook*. Washington, DC: U.S. Department of Housing and Urban Development. http://portal.hud.gov/hudportal/documents/huddoc?id=Section30Guidebook.pdf.

———. 2011. *Guidance on Energy Performance Contracts*. Washington, DC: U.S. Department of Housing and Urban Development. https://portal.hud.gov/hudportal/documents/huddoc?id=pih2011-36.pdf.

———. 2014. *Guidance on On-Site Utility Technologies and the Rate Reduction Incentive in Public Housing*. Washington, DC: U.S. Department of Housing and Urban Development. http://portal.hud.gov/hudportal/documents/huddoc?id=pih2014-18.pdf.

Appendix A

Questionnaire Administered to Study Participants

Evaluation of Energy Performance Contracts in Public Housing Authorities

Pre-Site Visit Questionnaire

INTRODUCTION

Welcome to the Evaluation of Energy Performance Contracts (EPCs) in Public Housing Authorities (PHAs). This questionnaire is part of research being conducted by the U.S. Department of Housing and Urban Development (HUD), Office of Policy Development and Research (PD&R), which provides reliable and objective research to help the Department make policy decisions.

HUD's Office of Public and Indian Housing (PIH) reports that the Department has approved over 250 EPCs, totaling nearly $1 billion in investments since this type of financing technique began in the 1980s[1]. EPCs have been executed in all 10 HUD regions and in PHAs ranging from very small (fewer than 250 units) to very large (6,600 units or more). To date, however, there is limited research on the effectiveness and value of these contracts.

PD&R's current research is a preliminary examination and documentation of the savings, benefits, and lessons learned from the EPC program at a small number of PHAs. In addition to this questionnaire, PD&R intends to conduct site visits and in-person discussions with PHA staff, examine installed utility improvements, and collect other EPC-related data.

This baseline study will provide a better understanding of the costs incurred by participating PHAs as they have implemented their PHAs. Furthermore, the study will be used to design a more informed and comprehensive cost-benefit analysis proposed to begin in FY16.

These research efforts will be key to HUD's long-term strategies, in part because the EPC program is being affected by the advent of HUD's Rental Assistance Demonstration[2] (RAD), which removes projects from HUD's public housing inventory and possibly from the EPC funding stream.

---

[1] U.S. Department of Housing and Urban Development, "EPC Database: Summary Statistics," http://portal.hud.gov/huddoc/2011EPCInventory.xls.

[2] U.S. Department of Housing and Urban Development, "Rental Assistance Demonstration," http://portal.hud.gov/hudportal/HUD?src=/RAD.

Please submit (via email) your completed survey to: michael.j.early@hud.gov and michael.d.blanford@hud.gov.

If you have questions regarding the questionnaire and/or the study, please contact Mr. Michael J. Early, Research Engineer, Office of Policy Development and Research, HUD at: (202) 402-2566 or michael.j.early@hud.gov or Mr. Michael D. Blanford, Research Engineer, Office of Policy Development and Research, HUD at: (202) 402-5728 or michael.d.blanford@hud.gov.

BACKGROUND

EPCs are an innovative financing technique designed to provide customers with cost-effective improvements—energy conservation measures (ECMs)—that are installed without up-front expenditures. The costs of the improvements are borne by the performance contractor and repaid using a portion of the cost savings resulting from the improvements. Due to the complexities and risks associated with estimating the savings and acquiring the improvements, EPCs are often performed by Energy Service Companies (ECSOs)—firms that provide a broad range of energy services, including design, acquisition, installation, testing, operation, and measurement and verification (M&V) of the installed improvements.

An ESCo's business model is driven by the upfront cost of the installed improvements and estimated flow of savings that will accrue during the improvement's payback period. As a result, ESCos may have incentives not to favor projects with high initial costs and long payback periods, but instead, to focus on 'low hanging fruit' (i.e., those of low cost, simpler complexity, and shorter payback periods).

HUD's EPC program provides PHAs with four incentives[3] to fund energy conservation improvements: Frozen Rolling Base Incentive (FRB), Add-On Subsidy Incentive (AOS), Resident-Paid Utility Incentive (RPU), and Rate Reduction Incentive (RRI). The FRB, AOS, and RPU incentives are designed to reduce PHA utility consumption relative to an established baseline, while the RRI allows PHAs to collect resultant cost savings from actions aimed at reducing the utility rate paid. Each of these incentives consists of unique requirements. But in total, they are designed to provide PHAs cost savings that enable them to allocate more of their operating subsidy toward needed repairs and other eligible expenses.

GUIDE TO THE QUESTIONNAIRE

Your housing authority is being asked to complete this questionnaire because you have expressed an interest and availability to participate and PD&R has selected your PHA for this study.

[3] U.S. Government of Publishing Office. Code of Federal Regulations. Title 24, Section 990.185. Utilities expense level: Incentives for energy conservation/rate reduction. 2011.

This questionnaire will examine PHAs that have executed an EPC and examine: 1) the achieved long-term utility savings; 2) how the resultant cost savings have been utilized; 3) the process, time, and workload, from the PHA's perspective, associated with applying to the EPC program, and 4) the identified barriers to entering the EPC program.

There are a total of 4 sections to this questionnaire.

- Section A asks about general EPC-related questions.
- Section B asks about utility conservation and cost savings.
- Section C asks about developing and managing an EPC.
- Section D asks about resident-related matters pertaining to the executed EPC.

To respond to the questionnaire, the respondents will need to have an understanding of the EPC that has been executed at your housing authority.

Generally, respondents should provide information about their housing authority's EPC and viewpoints as they exist today. Some questions, however, will specifically ask for historical information (e.g., a question may include a phrase such as "in hindsight") or projected information (e.g., a question may include a phrase such as "in the future").

Please answer the questions by providing a response that comes closest to describing details related to ***your Housing Authority's perspective*** on the executed EPC.

A response is required for all questions marked with an ***asterisk (*)***.

If your EPC has performed multiple phases for the executed EPC, please provide your responses relative to the information described in the Summary of Energy Performance Contracts (EPC) table listed on page. 4.

PD&R will use responses to this questionnaire only for research purposes. No information provided for this study will be used for compliance monitoring.

Following collection and analysis, aggregated results will be published for all interested parties (independent of participation in the collection) to use. The published data will consist of aggregated results and NOT contain information that can be used to identify specific housing authorities.

SUMMARY OF ENERGY PERFORMANCE CONTRACTS (EPCS)

For the purposes of this study, Departmental records indicate the following information related to your PHA's executed EPC. Please review the information below to ensure that the PD&R Research Team has an accurate account of the executed EPC.

If any of this information is incorrect or missing, please select this box ☐ and provide the correct information further below.

Public Housing Authority

PHA Characteristics	Total Contract Costs:	HUD Incentives (% of Project Costs)	M&V Risk
# of Affected Units	Financing Costs	Frozen Rolling Base	Measured
# of Developments (Projects / Sites)	M&V Costs	Add-On Subsidy	Stipulated
ESCo	Maintenance Costs	Resident Paid Utilities	
Contract Term (yrs)	Replacement Costs	Rate Reduction	1st Year Est. Savings
EPC Phase	Total Other Costs		Proj. Savings (over EPC term)
	Total Project Costs		

In the area below, please describe any necessary corrections to the information listed above.

Section A: General EPC-Related Questions

*1. For the executed EPC, who performed the investment grade energy audit (IGEA)?

- ☐ ESCo that managed/managing the EPC (**SKIP TO Question 3**)
- ☐ 3rd-party Consultant
- ☐ Other

2. Please identify the entity that performed the IGEA.

*3. Is your PHA satisfied with the completed IGEA?

- ☐ Yes (**SKIP TO Question 6**)
- ☐ No

4. If you were not satisfied with the completed IGEA, what are the reasons for your dissatisfaction? (**Check all that apply**)

- ☐ Audit didn't correctly scope out the necessary work
- ☐ Audit didn't reveal any information that wasn't already known
- ☐ Other (**GO TO Question 5**)

5. If you selected "Other" for Question 4, please identify the other reasons for your dissatisfaction with the IGEA.

*6. During the development process of the executed EPC, who developed the list of recommended improvements? (**Check all that apply**)

- ☐ ESCo that managed/managing the EPC
- ☐ Third-party Consultant
- ☐ PHA staff
- ☐ Other (**GO TO Question 7**)

7. If you selected "Other" for Question 6, please identify the other entities that developed the list of recommended improvements for your executed EPC?

*8. What factors were considered when developing the list of recommended improvements? (**Check all that apply**)

- ☐ Findings from the performed IGEA
- ☐ Capital Fund Program Five-Year Action Plan
- ☐ REAC Physical Inspection
- ☐ Routine inspections performed by PHA staff
- ☐ Concerns raised by residents
- ☐ Other (**GO TO Question 9**)

9. If you selected "Other" for Question 8, please identify the other factors that were considered when the recommended list of improvements was developed.

*10. Were all of the recommended improvements incorporated in to the Energy Service Agreement (ESA) and installed under the executed EPC?

- ☐ Yes (**SKIP TO Question 13**)
- ☐ No

11. If only a portion of the recommended improvements were installed, why was that? (**Check all that apply**)

- ☐ Lack of funding
- ☐ Additional improvements were or will be performed using other funds (e.g., Capital Improvement)
- ☐ Additional improvements were or will be deferred to a subsequent period of time
- ☐ Executed EPC would not have been cost-effective if additional improvements were installed

☐ Other (**GO TO Question 12**)

12. If you selected "Other" for Question 11, please identify the other reasons for installing only a portion of the recommended improvements.

*13. Was or will the total cost of the executed EPC be within the Energy Service Agreement's (ESA) initial estimated budget?

☐ Yes (**SKIP TO Question 17**)
☐ No

14. If cost overruns occurred, how much more was or will the total cost of the executed EPC be relative to the contract's initial estimated budget?

☐ <25%
☐ 26-50%
☐ 51-75%
☐ >75%

15. What were the reasons for the cost overruns? (**Check all that apply**)

☐ Incorrect improvements were bought or installed
☐ Changes in the type or quantity of installed improvements
☐ Initial cost of improvements or services changed
☐ Other (**GO TO Question 16**)

16. If you selected "Other" for Question 15, please identify the other reasons why cost overruns occurred.

*17. Was the work associated with the construction phase of the executed EPC completed on schedule?

☐ Yes (**SKIP TO Question 20**)
☐ No

18. If schedule (construction phase) delays occurred, what were the reasons for the delays? (**Check all that apply**)

☐ Incorrect improvements were installed
☐ IGEA did not correctly scope out the work
☐ EPC work could not be performed until other improvements (e.g., capital improvements) were completed
☐ Other (**GO TO Question 19**)

19. If you selected "Other" for Question 18, please identify the other reasons why the schedule (construction phase) delays occurred.

Currently, HUD guidance specifies that the term of an EPC, including any applicable extensions, can be no more than 20 years. ***Questions 20-23 ask questions related to this limit.***

*20. If permissible under HUD guidelines, would your PHA consider completing another phase of the executed EPC?

☐ Yes
☐ No

*21. If HUD extended the maximum term of an EPC beyond 20 years, would your PHA consider adding another phase to your executed EPC?

☐ Yes
☐ No

*22. In hindsight, if the maximum term of an EPC was extended beyond 20 years, would your PHA have installed improvements that would have been more cost effective over the term of the EPC (i.e., provided greater long-term savings)?

☐ Yes
☐ No

*23. Does your PHA believe that extending the maximum term of an EPC beyond 20 years would encourage more PHAs to participate in the EPC program?

☐ Yes
☐ No
☐ Don't Know

*24 Is your PHA satisfied with the EPC incentives used?

☐ Yes
☐ No

*25. Does your PHA wish that other EPC incentives were used?

☐ Yes
☐ No (**SKIP TO Question 27**)

26. Excluding the incentives used in your executed EPC, what additional incentives would your PHA have used? (**Check all that apply**)

☐ Frozen-Rolling Base
☐ Add-On Subsidy
☐ Resident Paid Utility
☐ Rate Reduction Incentive

*27. Did your PHA leverage funds other than EPC funds to install additional improvements in conjunction with the executed EPC?

☐ Yes
☐ No (**SKIP TO Question 30**)

28. If other funds were leveraged, what type of funds were they? (**Check all that apply**)

☐ Capital Funds / Capital Reserves
☐ Direct Purchase
☐ Third-Party Leasing
☐ Power Purchase Agreement (PPA)
☐ Rebate Program
☐ Grant Program
☐ Bond Program
☐ Other (**GO TO Question 29**)

29. If you selected "Other" for Question 28, please identify the other leveraged funds.

Section B: Energy Conservation and Cost Savings

*30. How does your PHA monitor the performance of your executed EPC? (**Check all that apply**)

- ☐ Annual ESCo provided measurement and verification (M&V) reports
- ☐ PHA-based monitoring
- ☐ Independent third-party monitoring
- ☐ Other (**GO TO Question 31**)

31. If you selected "Other" for Question 30, please identify the other approaches toward monitoring your executed EPC.

32. If performance monitoring occurs in addition to the annual ESCo provided M&V reports, how frequently does this monitoring occur?

- ☐ Monthly
- ☐ Quarterly
- ☐ Every 6 months
- ☐ Randomly

*33. What is monitored and reported during the M&V process? (**Check all that apply**)

- ☐ Utility Consumption
- ☐ Utility Expenditures
- ☐ Equipment Life Expectancy

☐ Operation and Maintenance (O&M) Practices
☐ Other (**GO TO Question 34**)

34. If you selected "Other" for Question 33, please identify any other elements that are monitored during the M&V process.

*35. Since the completion of the construction phase for your executed EPC, how are the actual utility savings compared to the initial estimated savings?

☐ Performing as Projected (**SKIP TO Question 38**)
☐ Under Performing
☐ Over Performing (**SKIP TO Question 37**)

36. Please explain, to the best of your knowledge, why the improvements are *Under Performing*.

SKIP TO Question 38

37. Please explain, to the best of your knowledge, why the improvements are *Over Performing*.

*38. After paying the annual debt services on your executed EPC, does your PHA realize any excess savings?

☐ Yes
☐ No (**SKIP TO Question 40**)

39. How has your PHA used the achieved annual cost savings? (**Check all that apply**)

☐ Installed additional improvements by expanding the current EPC
☐ Accelerated debt service on the executed EPC
☐ Paid eligible operating expenses

*40. If HUD permitted PHAs to apply achieved utility savings from EPCs toward capital improvements, would this be of benefit to your PHA?

☐ Yes
☐ No

HUD guidance on the payment of EPC debt specifies that at least 75 percent of cost savings must be paid toward annual EPC debt services and project costs. ***Questions 41-43 ask questions related to this requirement.***

*41. Would your PHA have undertaken different or additional improvements if it was not required to pay 75 percent of the cost savings toward EPC debt services and project costs?

☐ Yes
☐ No

*42. Would lowering the amount (percentage) of cost savings that must be paid toward the debt service of an executed EPC be of benefit to your PHA?

☐ Yes
☐ No

*43. Similarly, do you think that lowering this amount (percentage) would encourage more PHAs to participate in the EPC program?

☐ Yes
☐ No
☐ Don't Know

Section C: Developing and Managing an EPC

*44. What selection factors did your PHA use to select the ESCo to develop and manage your executed EPC? (**Check all that apply**)

☐ Performed prior work for your PHA

☐ Performed prior work for your PHA
☐ Referred by another PHA
☐ Well known / established company
☐ PHA does not have the technical capacity to develop and manage an EPC
☐ N/A, the executed EPC is self-managed by our PHA (**SKIP Question 46**)
☐ Other (**GO TO Question 45**)

45. If you selected "Other" for Question 44, please identify the other factors that were used in choosing the selected ESCo.

SKIP TO Question 51

46. What were your reasons for self-managing the executed EPC? (**Check all that apply**)

☐ PHA staff is very knowledgeable of the known problems
☐ Prior experience with ESCos has illustrated that they are not of benefit
☐ Executed EPC consisted of improvements that do not require advanced technical skill
☐ PHA possess the necessary technical capacity to develop and manage an EPC
☐ Other (**GO TO Question 47**)

47. If you selected "Other" for Question 46, please identify the other reasons why your PHA chose to self-manage the executed EPC.

48. Was or is self-managing the executed EPC a burdensome process?

☐ Yes
☐ No

49. Were there any other issues related to self-managing the executed EPC that were particularly a positive or negative experience?

☐ Yes
☐ No (**SKIP TO Question 51**)

50. Please describe your positive or negative experiences related to self-managing your EPC (please be sure to specify whether you view each experience as positive or negative).

*51. If a PHA chose to self-manage an executed EPC, do you believe that the PHA should be compensated for this effort?

☐ Yes
☐ No (**SKIP TO Question 54**)

52. Please specify your recommended approach toward compensating a PHA for self-managing an executed EPC.

☐ Percentage ___ % (**write-in**) of the total cost of the executed EPC
☐ Percentage ___ % (**write-in**) of the total annual federal subsidy that the PHA receives from HUD
☐ Other (**GO TO Question 53**)

53. If you selected "Other" for Question 52, please identify the other recommended approaches for compensating a PHA for self-managing an EPC.

*54. If your PHA were to add an additional phase to your existing EPC or execute a new EPC in the future, would your PHA hire an ESCo or self-manage the contract?

☐ Hire an ESCo
☐ Self-manage

In order for a PHA's EPC to be approved, HUD must have determined that the contract's projected cost savings will reasonably cover the project's costs. The application process for applying to the EPC program requires PHAs to complete a Completeness Review Checklist and Technical Review Checklist. Reponses to these two checklists provide necessary information that is required for HUD to review an Energy Service Agreement (ESA). ***Questions 20-23 ask questions related to the benefit of executing and effort associated with applying to the EPC program.***

*55. Overall, do you believe that your executed EPC was of an actual benefit to your PHA?

☐ Yes (**SKIP TO Question 58**)
☐ No

56. Please specify the reasons why the executed EPC was not of benefit to your PHA. (**Check all that apply**)

☐ Additional EPC debt made it more difficult to manage our PHA
☐ After paying annual debt services, our PHA did or does not realize any excess savings.
☐ The realized cost savings are insignificant or minimal relative to the time and effort that was put in to applying to and managing the executed EPC.
☐ Other (**GO TO Question 57**)

57. If you selected "Other" for Question 56, please specify the reasons why the EPC was not of benefit to your PHA.

*58. In terms of the EPC application process, did your PHA keep record of the workload (i.e., labor hours) associated with applying to the program?

☐ Yes
☐ No (**SKIP TO Question 60**)

59. Please specify the aggregate amount of time (**write-in**) or range of time that your PHA staff dedicated to the executed EPC during the application process?

- ☐ _____ hours
- ☐ <160 hours (<4 weeks)
- ☐ 160 - 320 hours (4-8 weeks)
- ☐ 320 - 640 (8 - 16 weeks)
- ☐ >640 hours (>16 weeks)

*60. Do you think the rigor of the EPC application process is necessary for HUD to ensure that the project is cost effective?

- ☐ Yes
- ☐ No

*61. In hindsight, has it or would it have been, of benefit to your PHA to hire a staff member whose sole responsibility was to develop, apply to, and manage the executed EPC?

- ☐ Yes
- ☐ No

*62. In the absence of the executed EPC, would your PHA have made the installed improvements anyway?

- ☐ Yes
- ☐ No (**GO TO Question 64**)
- ☐ Only a portion

63. Would your PHA have expected to achieve a similar amount of savings?

- ☐ Yes
- ☐ No

*64. In terms of installing additional utility improvements in the future, has the executed EPC enabled such work to be performed or hindered it?

- ☐ Enabled
- ☐ Hindered

*65. Please describe the ways in which the executed EPC has enabled or hindered future improvements.

*66. Has your PHA staff observed any specific issues with your executed EPC that you would advise other PHAs to avoid?

☐ Yes
☐ No (**SKIP TO Question 68**)

67. Please describe the issues that your PHA staff has observed.

*68. Does your PHA have any 'lessons learned' relating to the executed EPC?

☐ Yes
☐ No (**SKIP TO Question 70**)

69. Please describe the 'lessons learned.'

*70. Does the executed EPC have any specific clauses that were of benefit to your PHA?

☐ Yes
☐ No (**SKIP TO Question 72**)

71. Please describe the clauses and their benefit.

*72. Does the executed EPC have any specific clauses that were harmful or financially burdensome to your PHA?

☐ Yes
☐ No (**SKIP TO Question 74**)

73. Please describe the clauses that were harmful or financially burdensome.

*74. Is your PHA considering a conversion under the Rental Assistance Demonstration (RAD) program that involves EPC units?

☐ Yes
☐ No (**SKIP TO Question 77**)

75. From a utility performance and management perspective, does your PHA believe that the RAD conversion will be of benefit to your PHA?

☐ Yes
☐ No
☐ Don't Know (**SKIP TO Question 77**)

76. Please describe the reasons as to why the RAD conversion with EPC units will or will not be beneficial to your PHA.

Section D: Resident-Related Matters

*77. Were residents affected by the EPC informed of it (i.e., performance contract) significantly in advance of the contract's construction phase?

☐ Yes
☐ No

*78. Did the residents voice any concern about the improvements that were made under executed EPC?

☐ Yes
☐ No (**SKIP TO Question 81**)

79. What concerns did the residents raise?

80. Did your PHA have the necessary resources (e.g., money, staff time) to address residents' concerns?

☐ Yes
☐ No

81. To encourage greater utility conservation, were any resident outreach or training programs provided?

☐ Yes
☐ No (**SKIP TO Question 90**)

82. Who provided the outreach or training programs? (**Check all that apply**)

☐ PHA
☐ ESCo
☐ Third-party Consultant
☐ Other (**GO TO Question 83**)

83. If you selected "Other" for Question 82, please identify the other entities that provided the outreach or training programs.

84. How were the affected residents notified about the outreach or training programs?

- ☐ Posting of flyers
- ☐ PHA newsletters
- ☐ Resident meetings
- ☐ Other (**GO TO Question 85**)

85. If you selected "Other" for Question 84, please describe the other methods that were used to notify the affected residents about the provided outreach or training programs?

86. What percentage of the affected residents took part in the provided outreach or training programs?

- ☐ <10%
- ☐ 11-25%
- ☐ 26-50%
- ☐ 51-75%
- ☐ >75%
- ☐ Don't Know

87. Did the outreach or training programs assist the affected residents in their understanding of the importance of utility conservation?

- ☐ Yes
- ☐ No
- ☐ Don't Know

88. Since providing the outreach or training programs, has your PHA observed any changes in resident utility usage?

☐ Yes
☐ No
☐ Don't Know

89. Has your PHA found that the outreach or training programs resulted in supplemental savings relative to the improvements installed under the executed EPC?

☐ Yes
☐ No
☐ Don't Know

90. Would your PHA have an interest in participating in future HUD research about influencing resident behavior for utility conservation?

☐ Yes
☐ No

Thank you for completing this questionnaire! Your input is valuable to us, and we are grateful that you have shared your time and expertise.

Appendix B

Aggregate and Open-Ended Questionnaire Responses

Section A: General EPC-Related Questions

NOTE: For the purpose of confidentiality, the names of the respondents and their responses have been modified so that the information below cannot be used to identify specific housing authorities.

*1. For the executed EPC, who performed the investment grade energy audit (IGEA)?

Response	% (N)
ESCo that managed/managing the EPC	66.7 (6)
3rd-party Consultant	22.2 (2)
Other	11.1 (1)
Total	100.0 (9)

2. Please identify the entity that performed the IGEA.

Response	(N)
Entity identified (see below)	(3)

Public Housing Authority	Response
PHA 1	Company A
PHA 2	Company B
PHA 3	We had multiple audits. Company C & Company D.

*3. Is your PHA satisfied with the completed IGEA?

Response	% (N)
Yes	88.9 (8)
No	11.1 (1)
Total	100.0 (9)

4. If you were not satisfied with the completed IGEA, what are the reasons for your dissatisfaction? (**Check all that apply**)

Response	% (N)
Audit didn't correctly scope out the necessary work	0 (0)
Audit didn't reveal any information that wasn't already known	0 (0)
Other	100.0 (1)
Total	100.0 (1)

Note: Percentages may not equal 100.0 because multiple responses could be selected.

5. If you selected “Other” for Question 4, please identify the other reasons for your dissatisfaction with the IGEA.

Response	(N)
Other reasons for dissatisfaction with IGEA (see below)	(1)

Public Housing Authority	Response
PHA 4	The initial effort to start the installation, the change in equipment proposed, and the resulting cost to ESCo vs. charges to PHA 4.

*6. During the development process of the executed EPC, who developed the list of recommended improvements? (**Check all that apply**)

Response	% (N)
ESCo that managed/managing the EPC	77.8 (7)
Third-party Consultant	33.3 (3)
PHA staff	100.0 (9)
Other	0.0 (0)

Note: Percentages may not equal 100.0 because multiple responses could be selected.

Response	(N)
Additional comments (see below)	(1)

Public Housing Authority	Response
PHA 1	Third-party Consultant - selected high return ECMs PHA staff - selected high value ECMs

7. If you selected “Other” for Question 6, please identify the other entities that developed the list of recommended improvements for your executed EPC?

Response	(N)
Other reasons for other entities that developed the list of recommended improvements	(0)

*8. What factors were considered when developing the list of recommended improvements? (**Check all that apply**)

Response	% (N)
Findings from the performed IGEA	100.0 (9)
Capital Fund Program Five-Year Action Plan	100.0 (9)
REAC Physical Inspection	77.8 (7)
Routine inspections performed by PHA staff	77.8 (7)
Concerns raised by residents	44.4 (4)
Other	11.1 (1)

Note: Percentages may not equal 100.0 because multiple responses could be selected.

9. If you selected "Other" for Question 8, please identify the other factors that were considered when the recommended list of improvements was developed.

Response	(N)
Other factors that were considered when the recommended improvements were developed (see below)	(1)

Public Housing Authority	Response
PHA 1	Utility Conservation

*10. Were all of the recommended improvements incorporated in to the Energy Service Agreement (ESA) and installed under the executed EPC?

Response	% (N)
Yes	14.3 (1)
No	85.7 (6)
Total	100.0 (7)

Response	(N)
Additional comments (see below)	(1)

Public Housing Authority	Response
PHA 1	N/A. No ESA was in place

11. If only a portion of the recommended improvements were installed, why was that? (**Check all that apply**)

Response	% (N)
Lack of funding	33.3 (3)
Additional improvements were or will be performed using other funds (e.g., Capital Improvement)	22.2 (2)
Additional improvements were or will be deferred to a subsequent period of time	22.2 (2)
Executed EPC would not have been cost-effective if additional improvements were installed	66.7 (6)
Other	11.1 (1)

Note: Percentages may not equal 100.0 because multiple responses could be selected.

12. If you selected "Other" for Question 11, please identify the other reasons for installing only a portion of the recommended improvements.

Response	(N)
Other reasons for installing only a portion of the recommended improvements (see below)	(1)

Public Housing Authority	Response
PHA 5	The then Executive Director made decisions alone without input of others including staff and Board. This was a big mistake.

*13. Was or will the total cost of the executed EPC be within the Energy Service Agreement's (ESA) initial estimated budget?

Response	% (N)
Yes	100.0 (8)
No	0.0 (0)
Total	100.0 (8)

Response	(N)
Additional comments (see below)	(1)

Public Housing Authority	Response
PHA 1	N/A. No ESA - but project was under budget.

14. If cost overruns occurred, how much more was or will the total cost of the executed EPC be relative to the contract's initial estimated budget?

Response	% (N)
<25%	11.1 (1)
26-50%	0.0 (0)
51-75%	0.0 (0)
>75%	0.0 (0)
Total	100.0 (1)

15. What were the reasons for the cost overruns? (**Check all that apply**)

Response	% (N)
Incorrect improvements were bought or installed	0.0 (0)
Changes in the type or quantity of installed improvements	0.0 (0)
Initial cost of improvements or services changed	0.0 (0)
Other	11.1 (1)

Note: Percentages may not equal 100.0 because multiple responses could be selected.

16. If you selected "Other" for Question 15, please identify the other reasons why cost overruns occurred.

Response	(N)
Other reasons why cost overruns occurred (see below)	(1)

Public Housing Authority	Response

PHA 6	A contingency was incorporated in the agreement to address issues with unknowns (i.e., rotted floors needing replacement prior to installation of toilets, problems with installation of HVAC equipment, etc.)

*17. Was the work associated with the construction phase of the executed EPC completed on schedule?

Response	% (N)
Yes	66.7 (6)
No	33.3 (3)
Total	100.0 (9)

18. If schedule (construction phase) delays occurred, what were the reasons for the delays? (**Check all that apply**)

Response	% (N)
Incorrect improvements were installed	11.1 (1)
IGEA did not correctly scope out the work	11.1 (1)
EPC work could not be performed until other improvements (e.g., capital improvements) were completed	0.0 (0)
Other	22.2 (2)

Note: Percentages may not equal 100.0 because multiple responses could be selected.

19. If you selected "Other" for Question 18, please identify the other reasons why the schedule (construction phase) delays occurred.

Response	(N)
Other reasons why schedule (construction phase) overruns occurred (see below)	(2)

Public Housing Authority	Response
PHA 1	The project was delayed due to the planting and establishment of draught tolerant/water efficient grasses, an ECM. During the construction period there was a drought and the water company placed water restricting on landscape irrigation. Therefore the planting of water efficient grasses had to be postponed until drought restrictions were lifted.
PHA 4	…related to the manner in which installation start was attempted/delayed.

Currently, HUD guidance specifies that the term of an EPC, including any applicable extensions, can be no more than 20 years. ***Questions 20-23 ask questions related to this limit.***

*20. If permissible under HUD guidelines, would your PHA consider completing another phase of the executed EPC?

Response	% (N)
Yes	77.8 (7)
No	22.2 (2)
Total	100.0 (9)

Response	(N)
Additional comments (see below)	(1)

Public Housing Authority	Response
PHA 4	Not necessary.

*21. If HUD extended the maximum term of an EPC beyond 20 years, would your PHA consider adding another phase to your executed EPC?

Response	% (N)
Yes	66.7 (6)
No	33.3 (3)
Total	100.0 (9)

Response	(N)
Additional comments (see below)	(1)

Public Housing Authority	Response
PHA 4	Not necessary.

*22. In hindsight, if the maximum term of an EPC was extended beyond 20 years, would your PHA have installed improvements that would have been more cost effective over the term of the EPC (i.e., provided greater long-term savings)?

Response	% (N)
Yes	77.8 (7)
No	22.2 (2)
Total	100.0 (9)

Response	(N)
Additional comments (see below)	(2)

Public Housing Authority	Response
PHA 1	Potentially
PHA 2	Solar

*23. Does your PHA believe that extending the maximum term of an EPC beyond 20 years would encourage more PHAs to participate in the EPC program?

Response	% (N)
Yes	62.5 (5)
No	12.5 (1)
Don't Know	25.0 (2)
Total	100.0 (8)

Response	(N)
Additional comments (see below)	(1)

Public Housing Authority	Response
PHA 1	But I think it would drive new/additional phases of existing EPCs

*24 Is your PHA satisfied with the EPC incentives used?

Response	% (N)
Yes	100.0 (9)
No	0.0 (0)
Total	100.0 (9)

*25. Does your PHA wish that other EPC incentives were used?

Response	% (N)
Yes	25.0 (2)
No	75.0 (6)
Total	100.0 (8)

26. Excluding the incentives used in your executed EPC, what additional incentives would your PHA have used? (**Check all that apply**)

Response	% (N)
Frozen-Rolling Base	11.1 (1)
Add-On Subsidy	11.1 (1)
Resident Paid Utility	11.1 (1)
Rate Reduction Incentive	33.3 (3)

Note: Percentages may not equal 100.0 because multiple responses could be selected.

*27. Did your PHA leverage funds other than EPC funds to install additional improvements in conjunction with the executed EPC?

Response	% (N)
Yes	62.5 (5)

No	37.5 (3)
Total	100.0 (8)

28. If other funds were leveraged, what type of funds were they? (**Check all that apply**)

Response	% (N)
Capital Funds / Capital Reserves	44.4 (4)
Direct Purchase	0.0 (0)
Third-Party Leasing	22.2 (2)
Power Purchase Agreement (PPA)	0.0 (0)
Rebate Program	44.4 (4)
Grant Program	11.1 (1)
Bond Program	0.0 (0)
Other	11.1 (0)

Note: Percentages may not equal 100.0 because multiple responses could be selected.

29. If you selected "Other" for Question 28, please identify the other leveraged funds.

Response	(N)
Other leveraged funds (see below)	(1)

Public Housing Authority	Response
PHA 7	ARRA Funds

Section B: Energy Conservation and Cost Savings

*30. How does your PHA monitor the performance of your executed EPC? (**Check all that apply**)

Response	% (N)
Annual ESCo provided measurement and verification (M&V) reports	77.8 (7)
PHA-based monitoring	66.7 (6)
Independent third-party monitoring	33.3 (3)
Other	11.1 (1)

Note: Percentages may not equal 100.0 because multiple responses could be selected.

31. If you selected "Other" for Question 30, please identify the other approaches toward monitoring your executed EPC.

Response	(N)
Other approaches toward monitoring (see below)	(1)

Public Housing Authority	Response
PHA 1	Annual third-party M&V report issued. Also, the EPC funded an Energy Manager position which provides continual oversight over the EPC, utility consumption,

	and other energy and water conservation measures.

32. If performance monitoring occurs in addition to the annual ESCo provided M&V reports, how frequently does this monitoring occur?

Response	% (N)
Monthly	33.3 (3)
Quarterly	11.1 (1)
Every 6 months	0.0 (0)
Randomly	33.3 (3)

*33. What is monitored and reported during the M&V process? (**Check all that apply**)

Response	% (N)
Utility Consumption	88.9 (8)
Utility Expenditures	88.9 (8)
Equipment Life Expectancy	33.3 (3)
Operation and Maintenance (O&M) Practices	77.8 (7)
Other	22.2 (2)

Note: Percentages may not equal 100.0 because multiple responses could be selected.

Response	(N)
Additional comments (see below)	(1)

Public Housing Authority	Response
PHA 6	Equipment Life Expectancy -- completed at the energy audit phase

34. If you selected "Other" for Question 33, please identify any other elements that are monitored during the M&V process.

Response	(N)
Other elements that were monitored (see below)	(2)

Public Housing Authority	Response
PHA 1	Resident engagement programs focused on energy and water conservation
PHA 2	Physical Inspections are conducted to ensure EMC are still in place (aerators!) and operating according to specs, especially pressurized toilets.

*35. Since the completion of the construction phase for your executed EPC, how are the actual utility savings compared to the initial estimated savings?

Response	% (N)

Performing as Projected	77.8 (7)
Under Performing	11.1 (1)
Over Performing	11.1 (1)
Total	100.0 (9)

Response	(N)
Additional comments (see below)	(1)

Public Housing Authority	Response
PHA 8	Overall performance is to spec however individual ECMs are under/over performing

36. Please explain, to the best of your knowledge, why the improvements are *Under Performing*.

Response	(N)
Why improvements are Under Performing (see below)	(1)

Public Housing Authority	Response
PHA 6	Under performing due to not receiving full subsidy from HUD. Resident interference. Equipment control issues. Contract design establishes that saving at the beginning of contract is to be small and increase throughout term of contract.

SKIP TO Question 38

37. Please explain, to the best of your knowledge, why the improvements are *Over Performing*.

Response	(N)
Why improvements are Over Performing (see below)	(1)

Public Housing Authority	Response
PHA 1	1) Aggressive O&M procedures and 2) Resident engagement program

*38. After paying the annual debt services on your executed EPC, does your PHA realize any excess savings?

Response	% (N)
Yes	55.6 (5)
No	44.4 (4)
Total	100.0 (9)

Response	(N)
Additional comments (see below)	(1)

Public Housing Authority	Response
PHA 6	Not yet due to subsidy issues and contract design

39. How has your PHA used the achieved annual cost savings? (**Check all that apply**)

Response	% (N)
Installed additional improvements by expanding the current EPC	33.3 (3)
Accelerated debt service on the executed EPC	11.1 (1)
Paid eligible operating expenses	33.3 (3)

Note: Percentages may not equal 100.0 because multiple responses could be selected.

Response	(N)
Additional comments (see below)	(2)

Public Housing Authority	Response
PHA 1	Other - annual savings which exceed debt service fund EPC program costs including M&V activities and replacement equipment reserves
PHA 5	Into a subsequent phase

*40. If HUD permitted PHAs to apply achieved utility savings from EPCs toward capital improvements, would this be of benefit to your PHA?

Response	% (N)
Yes	85.7 (6)
No	14.3 (1)
Total	100.0 (7)

Response	(N)
Additional comments (see below)	(2)

Public Housing Authority	Response
PHA 1	Although energy related capital improvements are best - savings offset costs
PHA 3	Not sure

HUD guidance on the payment of EPC debt specifies that at least 75 percent of cost savings must be paid toward annual EPC debt services and project costs. ***Questions 41-43 ask questions related to this requirement.***

*41. Would your PHA have undertaken different or additional improvements if it was not required to pay 75 percent of the cost savings toward EPC debt services and project costs?

Response	% (N)
Yes	33.3 (3)
No	66.7 (6)
Total	100.0 (9)

Response	(N)
Additional comments (see below)	(1)

Public Housing Authority	Response
PHA 1	Potentially

*42. Would lowering the amount (percentage) of cost savings that must be paid toward the debt service of an executed EPC be of benefit to your PHA?

Response	% (N)
Yes	75.0 (6)
No	25.0 (2)
Total	100.0 (8)

*43. Similarly, do you think that lowering this amount (percentage) would encourage more PHAs to participate in the EPC program?

Response	% (N)
Yes	71.4 (5)
No	0.0 (0)
Don't Know	28.6 (2)
Total	100.0 (7)

Section C: Developing and Managing an EPC

*44. What selection factors did your PHA use to select the ESCo to develop and manage your executed EPC? (**Check all that apply**)

Response	% (N)
Performed prior work for your PHA	11.1 (1)
Referred by another PHA	33.3 (3)
Well known / established company	44.4 (4)
PHA does not have the technical capacity to develop and manage an EPC	33.3 (3)
N/A, the executed EPC is self-managed by our PHA	22.2 (2)
Other	44.4 (4)

Note: Percentages may not equal 100.0 because multiple responses could be selected.

45. If you selected "Other" for Question 44, please identify the other factors that were used in choosing the selected ESCo.

Response	(N)
Other factors used in choosing the selected ESCo (see below)	(4)

Public Housing Authority	Response
PHA 9	Request for proposals. Evaluation committee.
PHA 3	Firm selected through RFQ process. With other authorities.
PHA 6	The selection process was as follows: The Housing Authority was contacted by an ESCo to determine if an EPC was possible, after a brief investigation it was determined that an EPC is possible. A Request for Proposal was prepared and advertised and seven responses were received. Those seven proposals were evaluated and scored using a set of criteria which includes the items checked in #44 above. The top three were interviewed and following the interview process the top three were scored again. The top scoring firm was then selected.
PHA 8	Stated they were primarily interested in small PHAs.

SKIP TO Question 51

46. What were your reasons for self-managing the executed EPC? (**Check all that apply**)

Response	% (N)
PHA staff is very knowledgeable of the known problems	11.1 (1)
Prior experience with ESCos has illustrated that they are not of benefit	11.1 (1)
Executed EPC consisted of improvements that do not require advanced technical skill	11.1 (1)
PHA possess the necessary technical capacity to develop and manage an EPC	11.1 (1)
Other	22.2 (2)

Note: Percentages may not equal 100.0 because multiple responses could be selected.

47. If you selected "Other" for Question 46, please identify the other reasons why your PHA chose to self-manage the executed EPC.

Response	(N)

Other factors why your PHA choose to self-manage the executed EPC (see below)	(2)

Public Housing Authority	Response
PHA 1	Prior experience with ESCos has illustrated that they are not of benefit too expensive 1) Significantly lower project soft costs which allowed for a greater investment in capital improvements throughout the portfolio. 2) The self-managed EPC allowed for a greater involvement with Maintenance staff and residents which ultimately makes a stronger project with more durable savings. 3) Project scope can be more customized to meet the PHA's needs.
PHA 2	Reduction in Admin Cost of project. EPC Phase I was successful and had a much more complex scope. In-house staff was qualified to deliver the subsequent phase's scope so no need to incur substantial ESCo fees.

48. Was or is self-managing the executed EPC a burdensome process?

Response	% (N)
Yes	100.0 (1)
No	0.0 (0)
Total	100.0 (1)

Response	(N)
Additional comments (see below)	(1)

Public Housing Authority	Response
PHA 1	Developing a self-managed EPC takes a significant amount of staff time, however it is well worth the investment.

49. Were there any other issues related to self-managing the executed EPC that were particularly a positive or negative experience?

Response	% (N)
Yes	100.0 (2)
No	0.0 (0)
Total	100.0 (2)

50. Please describe your positive or negative experiences related to self-managing your EPC (please be sure to specify whether you view each experience as positive or negative).

Response	(N)
Positive or negative experiences related to self-managing an EPC (see below)	(2)

Public Housing Authority	Response
PHA 1	Positive - Explained in question #47. Negative -It does take a large amount of staff time, however the staff involvement is the exact reason the benefits in question #47 are achieved.
PHA 2	Positive - Reduction in soft costs was substantial down from more than 55% of hard cost for the initial phase to projected 29% in the subsequent phase. Negative - HUD Review took a very long time in securing financing at a good rate was challenging without ESCo partner.

*51. If a PHA chose to self-manage an executed EPC, do you believe that the PHA should be compensated for this effort?

Response	% (N)
Yes	66.7 (6)
No	33.3 (3)
Total	100.0 (9)

Response	(N)
Additional comments (see below)	(1)

Public Housing Authority	Response
PHA 1	PHA 1 was compensated

52. Please specify your recommended approach toward compensating a PHA for self-managing an executed EPC.

Response	% (N)
Percentage ___ % (**write-in**) of the total cost of the executed EPC	44.4 (4)
Percentage ___ % (**write-in**) of the total annual federal subsidy that the PHA receives from HUD	0.0 (0)
Other	11.1 (1)
Total	100.0 (5)

Response	(N)
Additional comments (see below)	(4)

Public Housing Authority	Response
PHA 1	15 - 10% of the total cost Similar to capital fund projects and/or development fees from

	self-development activities
PHA 4	10% of the total cost
PHA 5	18% of the total cost
PHA 7	10% of the total cost

53. If you selected "Other" for Question 52, please identify the other recommended approaches for compensating a PHA for self-managing an EPC.

Response	(N)
Other recommended approaches for compensating a PHA self-managing an EPC (see below)	(1)

Public Housing Authority	Response
PHA 2	15% of hard cost fee to the COCC.

*54. If your PHA were to add an additional phase to your existing EPC or execute a new EPC in the future, would your PHA hire an ESCo or self-manage the contract?

Response	% (N)
Hire an ESCo	62.5 (5)
Self-manage	37.5 (3)
Total	100.0 (8)

In order for a PHA's EPC to be approved, HUD must have determined that the contract's projected cost savings will reasonably cover the project's costs. The application process for applying to the EPC program requires PHAs to complete a Completeness Review Checklist and Technical Review Checklist. Reponses to these two checklists provide necessary information that is required for HUD to review an Energy Service Agreement (ESA). ***Questions 20-23 ask questions related to the benefit of executing and effort associated with applying to the EPC program.***

*55. Overall, do you believe that your executed EPC was of an actual benefit to your PHA?

Response	% (N)
Yes	88.9 (8)
No	11.1 (1)
Total	100.0 (9)

56. Please specify the reasons why the executed EPC was not of benefit to your PHA. (**Check all that apply**)

Response	% (N)
Additional EPC debt made it more difficult to manage our PHA	0.0 (0)
After paying annual debt services, our PHA did or does not realize any excess savings.	0.0 (0)
The realized cost savings are insignificant or minimal relative to the time	11.1 (1)

and effort that was put in to applying to and managing the executed EPC.	
Other	0.0 (0)

Note: Percentages may not equal 100.0 because multiple responses could be selected.

57. If you selected "Other" for Question 56, please specify the reasons why the EPC was not of benefit to your PHA.

Response	(N)
Other reasons why the EPC was not of benefit to your PHA	(0)

*58. In terms of the EPC application process, did your PHA keep record of the workload (i.e., labor hours) associated with applying to the program?

Response	% (N)
Yes	11.1 (1)
No	88.9 (8)
Total	100.0 (9)

59. Please specify the aggregate amount of time (**write-in**) or range of time that your PHA staff dedicated to the executed EPC during the application process?

Response	% (N)
_____ hours	0.0 (0)
<160 hours (<4 weeks)	0.0 (0)
160 - 320 hours (4-8 weeks)	0.0 (0)
320 - 640 (8 - 16 weeks)	100.0 (1)
>640 hours (>16 weeks)	0.0 (0)
Total	100.0 (1)

*60. Do you think the rigor of the EPC application process is necessary for HUD to ensure that the project is cost effective?

Response	% (N)
Yes	77.8 (7)
No	22.2 (2)
Total	100.0 (9)

Response	(N)
Additional comments (see below)	(1)

Public Housing Authority	Response
PHA 7	HUD approval for our subsequent phase took 9 months.

*61. In hindsight, has it or would it have been, of benefit to your PHA to hire a staff member whose sole responsibility was to develop, apply to, and manage the executed EPC?

Response	% (N)
Yes	44.4 (4)
No	55.5 (5)
Total	100.0 (9)

Response	(N)
Additional comments (see below)	(3)

Public Housing Authority	Response
PHA 1	PHA 1 has such staff member which was funded through the EPC
PHA 5	Too Costly
PHA 8	If funding was available

*62. In the absence of the executed EPC, would your PHA have made the installed improvements anyway?

Response	% (N)
Yes	0.0 (0)
No	11.1 (1)
Only a portion	88.9 (8)
Total	100.0 (9)

Response	(N)
Additional comments (see below)	(1)

Public Housing Authority	Response
PHA 7	Would not have done marginally cost effective measures.

63. Would your PHA have expected to achieve a similar amount of savings?

Response	% (N)
Yes	14.3 (1)
No	85.7 (6)
Total	100.0 (7)

*64. In terms of installing additional utility improvements in the future, has the executed EPC enabled such work to be performed or hindered it?

Response	% (N)
Enabled	87.5 (7)

Hindered	12.5 (1)
Total	100.0 (8)

Response	(N)
Additional comments (see below)	(1)

Public Housing Authority	Response
PHA 8	Neither

*65. Please describe the ways in which the executed EPC has enabled or hindered future improvements.

Response	(N)
Other reasons why the EPC enabled or hindered future improvements (see below)	(9)

Public Housing Authority	Response
PHA 9	Future improvements were not enabled or hindered but the question had to be answered.
PHA 1	The EPC enhanced our staff's engagement and recommendations with utility improvements and funding from local utilities assisted in such improvements.
PHA 2	Have developed a good working relationship with Company E who also serves as the authority's bank of record for other business lines. Self-managed EPC made them more aware of our various programs and should make future financing easier to obtain. Also made staff and residents more aware of energy/utility impact on operations and cash flow.
PHA 4	The enhancement of an understanding of energy-savings potential.
PHA 3	We have a clear understanding of what opportunities are available and the methodology to move forward.
PHA 6	The EPC enabled improvements to be installed quicker than if financed with capital fund dollars. With the installation of the new equipment sooner additional operational cost savings is realized by the reduction in cost to operate the more efficient equipment. Also feeing up additional capital fund dollars for other much needed improvements.
PHA 5	Freed up capital funds that otherwise might have been needed to do some or all of the work funded by EPC.
PHA 8	No further improvements have been installed because of the EPC. ADA compliance and

	replacing aging systems is priority.
PHA 7	Knowledge gained through EPC project was used to develop energy standards for future construction projects.

*66. Has your PHA staff observed any specific issues with your executed EPC that you would advise other PHAs to avoid?

Response	% (N)
Yes	88.9 (8)
No	11.1 (1)
Total	100.0 (9)

Response	(N)
Additional comments (see below)	(1)

Public Housing Authority	Response
PHA 4	Maybe

67. Please describe the issues that your PHA staff has observed.

Response	(N)
Other issues that your PHA staff has observed (see below)	(8)

Public Housing Authority	Response
PHA 9	Making sure the ESCo is monitoring and conducting the M&V appropriately.
PHA 2	Not sharing EPC plan with entire organization, including residents.
PHA 4	Temperature-controlled thermostats
PHA 3	Always question and review costs thoroughly.
PHA 6	Problems with automated building control issues proper operation. Resident tampering with controls on the heating and cooling of their units.
PHA 5	Overhead percentage calculating of the vender should be carefully examined.
PHA 8	Think beyond just the systems being improved. Other related systems may be adversely impacted.
PHA 7	Certain installed measures were maintenance intensive and highly technical. Also, single zone VRV system was not appropriate for multi-tenant building.

*68. Does your PHA have any ‘lessons learned’ relating to the executed EPC?

Response	% (N)
Yes	100.0 (9)
No	0.0 (0)
Total	100.0 (9)

69. Please describe the 'lessons learned.'

Response	(N)
Described lessons learned (see below)	(9)

Public Housing Authority	Response
PHA 9	We updated units slated for redevelopment with major improvements.
PHA 1	Multiple. Would like to discuss in person.
PHA 2	Be sure to have potential lenders engaged early in process. We invested a lot of time in the project before determining if a lender would be comfortable with the self-managed program. Fortunately our "regular" bank also finances EPC contracts. The "niche" lenders for this type of work are not the most economically feasible to ensure a positive outcome.
PHA 4	The many facets of the process from procurement to completion.
PHA 3	Again always question costs. Also always seek alternative sources of funding.
PHA 6	The need for more resident training and energy awareness. Too much reliance on the ESCo for everything.
PHA 5	See above.
PHA 8	See 67.
PHA 7	Energy savings can easily be offset by increased maintenance costs for some measures

*70. Does the executed EPC have any specific clauses that were of benefit to your PHA?

Response	% (N)
Yes	22.2 (2)
No	77.8 (7)
Total	100.0 (9)

71. Please describe the clauses and their benefit.

Response	(N)
The described clauses and their benefit. (see below)	(3)

Public Housing Authority	Response
PHA 4	The annual increase in funds to satisfy the indebtedness
PHA 6	The Housing Authority procured legal counsel to review all contract documents to ensure our interest was protected.
PHA 7	Frozen base Cost savings applied to debt Duration of contract term

*72. Does the executed EPC have any specific clauses that were harmful or financially burdensome to your PHA?

Response	% (N)
Yes	22.2 (2)
No	77.8 (7)
Total	100.0 (9)

Response	(N)
Additional comments (see below)	(1)

Public Housing Authority	Response
PHA 4	Not that I recall.

73. Please describe the clauses that were harmful or financially burdensome.

Response	(N)
The described clauses that were harmful or financially burdensome. (see below)	(2)

Public Housing Authority	Response
PHA 5	M&V were excessive
PHA 7	1) Original EPC had a shared savings provision 2) Monitoring of stipulated savings seemed unnecessary 3) Requirement that excess savings be used primarily for further energy measures

*74. Is your PHA considering a conversion under the Rental Assistance Demonstration (RAD) program that involves EPC units?

Response	% (N)
Yes	62.5 (5)
No	37.5 (3)

Total	100.0 (8)

Response	(N)
Additional comments (see below)	(1)

Public Housing Authority	Response
PHA 1	Unsure

75. From a utility performance and management perspective, does your PHA believe that the RAD conversion will be of benefit to your PHA?

Response	% (N)
Yes	33.3 (2)
No	16.7 (1)
Don't Know	50.0 (3)
Total	100.0 (6)

76. Please describe the reasons as to why the RAD conversion with EPC units will or will not be beneficial to your PHA.

Response	(N)
Reasons why the RAD conversion with EPC units will or will not be beneficial to your PHA. (see below)	(3)

Public Housing Authority	Response
PHA 9	The EPC work did not modernize the PHA stock to make it more attractive to renters. The intended work to be done in conjunction with the RAD conversion will.
PHA 2	RAD conversion does not provide any specific benefits in terms of utilities or management. Some RAD conversions will however produce a financial benefit.
PHA 7	Lower utility costs or allowances. Frozen utility base benefit will survive term of EPC by being factored into contract rents.

Section D: Resident-Related Matters

*77. Were residents affected by the EPC informed of it (i.e., performance contract) significantly in advance of the contract's construction phase?

Response	% (N)
Yes	88.9 (8)
No	11.1 (1)
Total	100.0 (9)

*78. Did the residents voice any concern about the improvements that were made under executed EPC?

Response	% (N)
Yes	77.8 (7)
No	22.2 (2)
Total	100.0 (9)

79. What concerns did the residents raise?

Response	(N)
Concerns raised by residents. (see below)	(7)

Public Housing Authority	Response
PHA 9	Residents were upset about the limiting thermostats.
PHA 1	Residents were involved in project design and execution so the majority of the ECMs were favorable for the residents. Residents did show concerns on the following ECMs: 1) CFL bulbs - comments were received on the brightness and temperature 2) Native grasses - the look and feel are different than other grasses
PHA 2	Concerns that increased amenities like central air would actually raise utility costs for them.
PHA 4	Temperature-controlled thermostats. Bulbs for light fixtures.
PHA 6	Limited control of thermostats in their units which affected the ability to control the temperature in their unit. (the unit is either too cold or too hot).
PHA 5	Reduced heat in winter.
PHA 7	Felt that energy savings measures would impinge on their comfort - light intensity, ability to control thermostats, low-flow showers, etc.

80. Did your PHA have the necessary resources (e.g., money, staff time) to address residents' concerns?

Response	% (N)
Yes	100.0 (8)
No	0.0 (0)
Total	100.0 (8)

81. To encourage greater utility conservation, were any resident outreach or training programs provided?

Response	% (N)
Yes	100.0 (9)
No	0.0 (0)
Total	100.0 (9)

82. Who provided the outreach or training programs? (**Check all that apply**)

Response	% (N)
PHA	66.7 (6)
ESCo	66.7 (6)
Third-party Consultant	22.2 (2)
Other	0.0 (0)

Note: Percentages may not equal 100.0 because multiple responses could be selected.

Response	(N)
Additional comments (see below)	(1)

Public Housing Authority	Response
PHA 7	Provided consultant

83. If you selected "Other" for Question 82, please identify the other entities that provided the outreach or training programs.

Response	(N)
Other entities that provided the outreach or training programs.	(0)

84. How were the affected residents notified about the outreach or training programs?

Response	% (N)
Posting of flyers	100.0 (9)
PHA newsletters	33.3 (3)
Resident meetings	88.9 (8)
Other	22.2 (2)

Note: Percentages may not equal 100.0 because multiple responses could be selected.

85. If you selected "Other" for Question 84, please describe the other methods that were used to notify the affected residents about the provided outreach or training programs?

Response	(N)
Other methods that were used to notify the affected residents about the provided outreach or training programs. (see below)	(2)

Public Housing Authority	Response
PHA 1	Energy Fairs / Outreach programs
PHA 3	Phone calls via our robo system.

86. What percentage of the affected residents took part in the provided outreach or training programs?

Response	% (N)
<10%	22.2 (2)
11-25%	55.6 (5)
26-50%	11.1 (1)
51-75%	0.0 (0)
>75%	11.1 (1)
Don't Know	0.0 (0)

Note: Percentages may not equal 100.0 because multiple responses could be selected.

87. Did the outreach or training programs assist the affected residents in their understanding of the importance of utility conservation?

Response	% (N)
Yes	88.9 (8)
No	0.0 (0)
Don't Know	11.1 (1)
Total	100.0 (9)

88. Since providing the outreach or training programs, has your PHA observed any changes in resident utility usage?

Response	% (N)
Yes	22.2 (2)
No	33.3 (3)
Don't Know	44.4 (4)
Total	100.0 (9)

Response	(N)
Additional comments (see below)	(1)

Public Housing Authority	Response
PHA 7	Due to turnover of residents since program began

89. Has your PHA found that the outreach or training programs resulted in supplemental savings relative to the improvements installed under the executed EPC?

Response	% (N)
Yes	11.1 (1)
No	22.2 (2)
Don't Know	66.7 (6)
Total	100.0 (9)

90. Would your PHA have an interest in participating in future HUD research about influencing resident behavior for utility conservation?

Response	% (N)
Yes	88.9 (8)
No	11.1 (1)
Total	100.0 (9)

Thank you for completing this questionnaire! Your input is valuable to us, and we are grateful that you have shared your time and expertise.

Appendix C

Utility Expense Level Quantities

The tables below illustrate the Utility Expense Level (UEL) quantities for each of the study's participating PHAs. These quantities span from Funding Years 200–2015 (actual consumption spanning July 1, 2003 to June 30, 2014) and represent the annual self-reported, owner-paid utilities—electricity, natural gas, sewer, and water.

Because the UEL data are self-reported, multiple assumptions were made to correct for missing data and inconsistent units of consumption. For purposes of consistency, electricity and natural gas quantities are reported in kilowatt-hours (kWh) and sewer and water quantities are reported in gallons (gal). In addition, each table consists of notes describing the Funding Year in which the respective EPC(s) was initially observed, types of improvements installed, and incentives used.

Table 11: DE001[a]

Funding Year	Actual Consumption Timeframe	Electrical Consumption {kWh}	Natural Gas Consumption {kWh}	Sewer/Water Consumption {gal}
2005	7/1/2003 to 6/30/2004	5,042,802	148,729	131,446,000
2006	7/1/2004 to 6/30/2005	5,124,513	141,611	87,225,000
2007	7/1/2005 to 6/30/2006	4,566,268	127,802	98,313,000
2008	7/1/2006 to 6/30/2007	4,947,819	119,443	95,016,000
2009	7/1/2007 to 6/30/2008	3,567,527	80,535	94,037,000
2010	7/1/2008 to 6/30/2009	3,717,188	97,734	66,274,000
2011	7/1/2009 to 6/30/2010	3,642,395	73,146	80,027,000
2012	7/1/2010 to 6/30/2011	4,516,718	84,172	86,717,000
2013	7/1/2011 to 6/30/2012	3,118,544	49,741	65,812,000
2014	7/1/2012 to 6/30/2013	4,647,884	59,795	72,797,000
2015	7/1/2013 to 6/30/2014	5,292,764	85,734	80,848,000

[a] DE001 executed two EPC phases; the first being in Funding Year 2009 and the second in Funding Year 2015. During these phases, building envelope, HVAC, water, and appliance improvements were installed, and the FRB, AOS, and RPU incentives were used.

Table 12: PA04[a]

Funding Year	Actual Consumption Timeframe	Electrical Consumption {kWh}	Natural Gas Consumption {kWh}	Sewer Consumption {gal}	Water Consumption {gal}
2005	7/1/2003 to 6/30/2004	2,150,271	7,395,838	17,237,630	17,237,630
2006	7/1/2004 to 6/30/2005	2,213,064	7,628,810	18,603,220	18,603,220
2007	7/1/2005 to 6/30/2006	2,258,598	7,164,654	19,699,140	19,699,140
2008	7/1/2006 to 6/30/2007	2,215,474	6,840,533	15,569,880	15,569,880
2009	7/1/2007 to 6/30/2008	2,254,639	6,851,876	16,034,786	16,034,786
2010	7/1/2008 to 6/30/2009	2,316,832	6,990,621	16,801,364	16,801,364
2011	7/1/2009 to 6/30/2010	2,296,816	6,336,694	18,541,200	18,287,739
2012	7/1/2010 to 6/30/2011	2,483,074	6,391,940	19,645,543	19,657,493
2013	7/1/2011 to 6/30/2012	2,431,951	5,918,992	14,454,000	14,454,000
2014	7/1/2012 to 6/30/2013	1,915,528	5,105,305	8,705,000	8,705,000
2015	7/1/2013 to 6/30/2014	2,333,529	7,178,370	8,121,000	8,221,000

[a] PA040 executed one EPC phase in Funding Year 2013. During this phase, lighting, water, building envelope, and HVAC improvements were installed, and the FRP and RPU incentives were used.

Table 13: MS107[a]

Funding Year	Actual Consumption Timeframe	Electrical Consumption {kWh}	Natural Gas Consumption {kWh}	Sewer/Water Consumption {gal}[b]
2005	7/1/2003 to 6/30/2004	38,256	476	0
2006	7/1/2004 to 6/30/2005	18,474	149	0
2007	7/1/2005 to 6/30/2006	10,776	134	0
2008	7/1/2006 to 6/30/2007	20,339	149	0
2009	7/1/2007 to 6/30/2008	9,550	118	0
2010	7/1/2008 to 6/30/2009	22,199	277	0
2011	7/1/2009 to 6/30/2010	22,070	342	0
2012	7/1/2010 to 6/30/2011	32,518	253	0
2013	7/1/2011 to 6/30/2012	27,939	307	0
2014	7/1/2012 to 6/30/2013	32,001	350	0
2015	7/1/2013 to 6/30/2014	30,560	440	0

[a] MS107 executed one EPC phase in Funding Year 2011. During this phase, lighting, water, and HVAC improvements were installed, and the AOS incentive was used.
[b] The UEL data sets do not contain any measurements for owner-paid sewer and water quantities.

Table 14: AR002[a]

Funding Year	Actual Consumption Timeframe	Electrical Consumption {kWh}	Natural Gas Consumption {kWh}	Sewer/Water Consumption {gal}
2005	7/1/2003 to 6/30/2004	5,898,816	5,856,919	56,937,760
2006	7/1/2004 to 6/30/2005	5,889,920	8,104,750	61,084,672
2007	7/1/2005 to 6/30/2006	6,317,221	4,565,772	65,013,916
2008	7/1/2006 to 6/30/2007	5,969,673	4,936,117	61,303,088
2009	7/1/2007 to 6/30/2008	5,899,154	4,448,505	58,456,948
2010	7/1/2008 to 6/30/2009	5,780,815	4,579,103	53,973,436
2011	7/1/2009 to 6/30/2010	5,935,368	3,184,701	46,803,108
2012	7/1/2010 to 6/30/2011	5,948,630	2,803,869	38,139,024
2013	7/1/2011 to 6/30/2012	5,961,980	1,993,523	39,067,292
2014	7/1/2012 to 6/30/2013	5,578,305	2,542,907	40,866,232
2015	7/1/2013 to 6/30/2014	5,830,196	3,086,401	35,880,812

[a] AR002 executed one EPC phase in Funding Year 2009. During this phase, lighting, water, building envelope, and HVAC improvements were installed, and the AOS and RPU incentives were used.

Table 15: KS001[a]

Funding Year	Actual Consumption Timeframe	Electrical Consumption {kWh}	Natural Gas Consumption {kWh}	Sewer Consumption {gal}	Water Consumption {gal}
2005	7/1/2003 to 6/30/2004	10,870,732	26,359,222	68,955,128	80,045,724
2006	7/1/2004 to 6/30/2005	9,810,105	26,478,532	67,141,228	78,674,640
2007	7/1/2005 to 6/30/2006	10,999,419	37,983,274	54,260,668	78,180,212
2008	7/1/2006 to 6/30/2007	10,670,481	24,661,756	62,380,956	76,624,372
2009	7/1/2007 to 6/30/2008	11,102,241	21,033,928	76,313,204	75,693,860
2010	7/1/2008 to 6/30/2009	11,044,655	20,692,567	79,878,920	76,845,032
2011	7/1/2009 to 6/30/2010	11,195,548	20,992,049	79,248,356	78,080,728
2012	7/1/2010 to 6/30/2011	12,145,311	22,643,719	91,580,632	92,976,400
2013	7/1/2011 to 6/30/2012	10,409,304	17,677,864	49,366,504	49,267,020
2014	7/1/2012 to 6/30/2013	9,573,033	20,761,864	52,262,760	55,734,228
2015	7/1/2013 to 6/30/2014	10,831,402	28,679,452	63,476,776	74,025,820

[a] KS001 executed one EPC phase in Funding Year 2012. During this phase, building envelope, HVAC, lighting, water, appliances, renewable energy, and miscellaneous improvements were installed, and the FRB, AOS, and RPU incentives were used.

Table 16: CO001[a]

Funding Year	Actual Consumption Timeframe	Electrical Consumption {kWh}	Natural Gas Consumption {kWh}	Sewer/Water Consumption {gal}
2005	7/1/2003 to 6/30/2004	46,298,257	148,176,055	594,958,000
2006	7/1/2004 to 6/30/2005	45,273,665	186,349,678	557,665,000
2007	7/1/2005 to 6/30/2006	44,390,600	141,590,621	663,058,000
2008	7/1/2006 to 6/30/2007	46,781,675	136,385,756	666,901,000
2009	7/1/2007 to 6/30/2008	25,161,237	62,318,142	312,728,000
2010	7/1/2008 to 6/30/2009	24,282,647	58,051,143	286,425,000
2011	7/1/2009 to 6/30/2010	25,489,072	66,714,068	262,354,000
2012	7/1/2010 to 6/30/2011	24,352,108	59,929,484	335,776,000
2013	7/1/2011 to 6/30/2012	23,909,289	53,765,006	338,305,000
2014	7/1/2012 to 6/30/2013	24,366,741	56,546,630	309,952,000
2015	7/1/2013 to 6/30/2014	22,603,605	56,060,346	277,238,000

[a] CO001 executed two EPC phases; the first in Funding Year 2008 and the second in Funding Year 2012. During these phases, lighting, water, HVAC, appliances, and building envelope improvements were installed, and the AOS incentive was used.

Table 17: PA046[a]

Funding Year	Actual Consumption Timeframe	Electrical Consumption {kWh}	Natural Gas Consumption {kWh}	Sewer/Water Consumption {gal}
2005	7/1/2003 to 6/30/2004	1,684,918	4,530,973	14,156,449
2006	7/1/2004 to 6/30/2005	1,496,684	5,358,827	16,796,515
2007	7/1/2005 to 6/30/2006	1,798,230	5,888,735	17,361,489
2008	7/1/2006 to 6/30/2007	1,665,293	4,542,724	13,219,194
2009	7/1/2007 to 6/30/2008	3,728,914	7,523,170	22,929,549
2010	7/1/2008 to 6/30/2009	1,956,295	5,108,545	22,453,115
2011	7/1/2009 to 6/30/2010	1,950,257	3,932,763	14,635,134
2012	7/1/2010 to 6/30/2011	2,011,619	3,516,200	17,576,756
2013	7/1/2011 to 6/30/2012	1,753,170	2,638,875	13,315,092
2014	7/1/2012 to 6/30/2013	1,761,880	2,729,382	15,533,128
2015	7/1/2013 to 6/30/2014	2,256,947	2,583,317	11,939,043

[a] PA046 executed two EPC phases; the first in Funding Year 2010 and the second in Funding Year 2015. During these phases, lighting, water, building envelope, appliances, and HVAC improvements were installed, and the FRB and AOS incentives were used.

Table 18: TN005[a]

Funding Year	Actual Consumption Timeframe	Electrical Consumption {kWh}	Natural Gas Consumption {kWh}	Sewer/Water Consumption {gal}
2005	7/1/2003 to 6/30/2004	62,325,731	33,483,153	565,211
2006	7/1/2004 to 6/30/2005	60,515,937	31,909,397	532,351
2007	7/1/2005 to 6/30/2006	58,439,496	32,971,232	477,206
2008	7/1/2006 to 6/30/2007	56,268,782	31,839,257	263,952
2009	7/1/2007 to 6/30/2008	57,639,174	31,342,521	492,868
2010	7/1/2008 to 6/30/2009	57,653,281	31,313,296	496,867
2011	7/1/2009 to 6/30/2010	55,375,849	36,125,794	270,747
2012	7/1/2010 to 6/30/2011	53,540,620	29,995,305	211,918
2013	7/1/2011 to 6/30/2012	49,217,029	25,212,724	221,581
2014	7/1/2012 to 6/30/2013	50,027,105	29,409,206	220,149
2015	7/1/2013 to 6/30/2014	51,374,298	31,462,374	223,298

[a] TN005 executed three EPC phases; the first in Funding Year 1998, the second in Funding Year 2009, and third in Funding Year 2013. During these phases, building envelope, appliances, lighting, water, renewable energy, and HVAC improvements were installed, and the FRB and RPU incentives were used.

Table 19: NY025

Funding Year	Actual Consumption Timeframe	Electrical Consumption {kWh}	Natural Gas Consumption {kWh}	Sewer/Water Consumption {gal}
2005	7/1/2003 to 6/30/2004	470,498	4,052,931	0
2006	7/1/2004 to 6/30/2005	499,593	4,000,586	0
2007	7/1/2005 to 6/30/2006	469,099	3,596,542	0
2008	7/1/2006 to 6/30/2007	391,097	4,783,353	0
2009	7/1/2007 to 6/30/2008	457,186	3,153,664	0
2010	7/1/2008 to 6/30/2009	480,829	3,113,130	0
2011	7/1/2009 to 6/30/2010	468,163	2,896,717	0
2012	7/1/2010 to 6/30/2011	512,518	2,811,460	0
2013	7/1/2011 to 6/30/2012	465,479	2,208,382	0
2014	7/1/2012 to 6/30/2013	490,054	2,232,122	0
2015	7/1/2013 to 6/30/2014	473,932	2,298,359	0

[a] NY025 executed two EPC phases; the first in Funding Year 2008 and the second in Funding Year 2011. During these phases, building envelope, HVAC, lighting, and appliance improvements were installed, and the FRB and RPU incentives were used.
[b] The UEL data sets do not contain any measurements for owner-paid sewer and water quantities.

Appendix D

Sidebars and Photos

Lighting Systems

Indoor lighting systems, composed of compact fluorescent lamps (CFL) and light-emitting diodes (LED), were the most common improvement performed by the PHAs visited. These lighting systems employ bulbs that are available in a wide range of colors and light levels. ENERGY STAR-qualified CFL bulbs use about 75 percent less energy and can last up to 10 times longer than traditional incandescent bulbs. ENERGY STAR-qualified LEDs use even less energy than CFLs and can last up to 25 times longer than traditional incandescent bulbs.

Figure 3: CFL Lighting, Nashville Site Visit

Figure 4: Energy-Efficient Lighting, North Little Rock Site Visit

Water and Water Heating

Saving water is an important part of any EPC. Installing low-flow faucets and showerheads is an effective way to conserve water, reduce water heating costs, and save energy. The U.S. Environmental Protection Agency uses the WaterSense® label to identify water-efficient products such as showerheads, bathroom faucets, and toilets. WaterSense®-labeled products use a minimum of 20 percent less water compared with conventional products.

Figure 5: Natural Gas Water Heater, Denver Site Visit

Figure 6: Dual Flush Water-Efficient Toilet, Greenwood Site Visit

Figure 7: Tankless Water Heater, Watervliet Site Visit

Appliances

ENERGY STAR-certified appliances are often specified in EPCs. These appliances help save on operating costs by reducing energy use without sacrificing performance. For example, a new ENERGY STAR refrigerator will be about 30 percent more energy efficient than a comparably sized 20-year-old model.

Figure 8: Energy-Efficient Dryers, Clinton Site Visit

Figure 9: Energy-Efficient Refrigerator, Denver Site Visit

HVAC

While not as commonly installed as lighting and water systems, improved heating, ventilation, and air-conditioning (HVAC) systems hold great energy saving potential. High-efficiency heat pumps and boilers were installed at several sites. The ENERGY STAR label can be used to identify energy-efficient HVAC equipment suitable for single family or individual dwelling units. A qualified engineer should be consulted when specifying energy-efficient equipment in more complex, multifamily buildings, as HVAC product selection must be based on demand. ENERGY STAR-qualified room and central air conditioners use about 15 percent less energy compared with conventional air conditioner systems. ENERGY STAR-qualified furnaces and boilers are often substantially more efficient than their conventional counterparts, with *oil boilers* having annual fuel utilization efficiency (AFUE) *ratings* of 87 percent or greater and *gas boilers* having AFUE of 90 percent or greater.

Figure 10: Residential Unit Mini-Split Heat Pump System, Nashville Site Visit

Figure 11: Energy-Efficient Natural Gas Boiler, Wilmington Site Visit

Programmable Thermostats and Controls

Programmable thermostats can be set to reduce heating or air conditioning operations when residents are sleeping or not at home; for maximum efficiency, these periods of reduced operation should be at least 4 hours in duration. Programmable thermostats are capable of storing six or more daily temperature settings that can be manually overridden without affecting the other daily or weekly programs.

Figure 12: Programmable Thermostat, Clinton Site Visit

Figure 13: HVAC Control Panel, Nashville Site Visit

Renewable Energy Sources

In residential applications, the most common renewable energy systems are solar photovoltaic power, solar thermal energy, geothermal heating and cooling, and wind power. Biomass, biofuel, and hydroelectric (water turbine) systems are less commonly used in conjunction with an EPC but are not unknown. A qualified engineer with a background in renewable energy in the built environment should be consulted when considering the use of less common renewable sources, because some sources may yield better results in certain climates.

Figure 14: These Townhouse-Style Apartments Rely on Geothermal Heat Pumps To Substantially Reduce Both Demand and Associated Costs; Chester Site Visit

Figure 15: Geothermal Heat Pump, Chester Site Visit

Figure 16: Solar Panels Used for Domestic Hot Water, Chester Site Visit

Figure 17: Rooftop Solar Photovoltaic Panels, Kansas City Site Visit

Figure 18: Solar Water Heaters, Kansas City Site Visit

Figure 19: Rooftop Solar Photovoltaic Array, Watervliet Site Visit

U.S. Department of Housing and Urban Development
Office of Policy Development and Research
Washington, DC 20410-6000

June 2017