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Better bang for your buck? Comparing savings realization from ESPCs and direct-funded projects

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ABSTRACT

Energy savings performance contracts (ESPCs) offer an opportunity to tremendously scale decarbonization projects, given their paid-from-savings premise. However, prospective customers still question whether ESPC is worth the effort and expense. This study evaluates the savings realization rates of ESPCs compared to direct-funded projects using ENERGY STAR Portfolio Manager (ESPM) benchmarking data. It compares normalized EUIs from ESPM before and after energy conservation projects implemented via ESPC or direct funding in roughly 450 federal buildings. This documented change, ideally a savings, can then be compared to the *estimated* savings from the energy conservation initiative in order to generate a rough realization rate. Preliminary results indicate a notably greater savings realization rate for the ESPC buildings (median = 105% of estimated savings) than those that underwent direct-funded projects (median = 46%). Because of a shortage of good quality data and the wide range in results, the difference is only significant at the $p < 0.20$ level. However, the higher savings realization of ESPCs corroborates the authors' 2014 findings using a different comparison method. With continued soft government funding and regulatory impediments for climate change mitigation in the U.S., financed, paid-from-savings project models (e.g., ESPC, PACE, EaaS and others) certainly merit more attention. This study's results are particularly compelling (and encouraging) given the country's likely reliance on these vehicles to address existing building retrofits.

Introduction

Building managers are challenged daily with maintaining and operating their aging facilities. Additionally, in the federal sector, they are faced with various mandates, via laws and executive orders, to reduce energy use and GHG emissions towards a decarbonized future. One directive, the Energy Independence and Security Act of 2007 (EISA), requires federal agencies to reduce energy intensity by 3% annually beginning in FY 2006, up to a cumulative 30 percent reduction by the end of FY 2015 (compared to an FY 2003 baseline). One of the biggest barriers towards addressing these issues is the lack of upfront capital to finance these projects. However, alternative financing mechanisms can be employed that leverage the reduction in operating expenses to fund these projects. In addition, energy service companies (ESCOs) have the expertise to vet energy conservation measures (ECMs) and mitigate the performance and operating risks associated with the projects.

Energy savings performance contracting (ESPC) is one of the most common of these alternative financing mechanisms. ESPCs allow entities to acquire performance-based services to implement equipment and systems that reduce energy use and O&M expenses through projects designed, installed, and financed by ESCOs. In this way, paid-from-savings, ESPC projects allow agencies to reallocate some of their utility and O&M expenses to pay for energy system infrastructure improvements rather than fuel and electricity. These projects are prominent in the public sector entities, including the federal government. The most widely used vehicle for implementing ESPC projects in the federal government is the indefinite quantity contract administered by the U.S. Department of Energy's (DOE's) Federal Energy Management Program (FEMP). The DOE-FEMP ESPC indefinite delivery, indefinite quantity (IDIQ) contract is designed to make ESPCs as practical and cost-effective a tool as possible for federal agencies. Using IDIQ contracts, agencies can implement ESPC projects in far less time than it takes to develop stand-alone ESPC projects. Since 1998, federal agencies have used the FEMP IDIQ to award almost 450 projects and installed roughly $8 billion worth of energy improvements (DOE 2022). These improvements would result in about $18 billion in cumulative energy cost savings for the federal government over their contract term.

Oak Ridge National Laboratory reports realization rates of federal ESPCs based on the information reported in the ESCOs' annual M&V reports. Analyzing the data from 187 M&V reports for 183 active projects (Walker 2020), ORNL identified annual guaranteed cost savings of $351 million. Their review indicates that ESCOs reported achieving 109.5% of their guaranteed cost savings and 100.3% of the estimated savings of 14 million MMBtu (ESCOs' guarantees always represent a slight de-rating of their estimated savings to account for project risks).

Despite the high reported savings realization rate among ESPC projects, some degree of skepticism remains about their "true" performance. Measurement and verification (M&V) of the projects, the process of assessing the degree to which the savings are achieved, is conducted by the ESCOs themselves, which some consider to be a conflict of interest. However, the federal agencies "witness" and review the M&V, which is aimed at fortifying the legitimacy of the reported savings. The FEMP program maintains increasingly robust M&V standards, based on the International Performance Measurement and Verification Protocol (EVO 2022) and FEMP's own M&V guidelines (FEMP 2015) as discussed in a recent study by the authors (Coleman et al. 2020). Yet some federal agencies maintain M&V practices that are even more stringent, arguing that many ESPCs have underperformed on their savings guarantees (Lally 2008).

To independently evaluate the savings realization rates of these projects properly and objectively, actors should conduct the evaluations, ideally divorced from any knowledge of the party responsible for implementing the project. For ESPCs, this is a substantial undertaking, as most of these projects involve multiple millions in investment and many ECMs. In 2014, the authors compared the reported savings from ESPCs with those of direct-funded interventions in a Department of Energy database of federal energy projects, and found substantially higher savings realization rates for ESPCs (Coleman, Earni, and Williams 2014). However, the finding came with a very large caveat: results of the direct funded projects were reported by federal employees or on-site O&M contractors, while the ESPC savings reporting came from the ESCOs. ESCOs, of course, have a vested interest in the (guaranteed) savings materializing – if they don't, they pay for the shortfall. This alone deemed the side-by-side savings comparison suspect, as the authors conceded. Another study (Urbatsch and Boyer 2016), evaluated the performance of (primarily non-federal) ESPC projects at a more aggregate level, by looking at pre- and post-intervention whole building meter results (i.e., IPMVP Option C M&V), unadjusted for changes in occupancy, building footprint, hours of operation, or any other factors besides weather and found low savings realization.

Outside of the latter paper, there appears to be no research on ESPCs' performance beyond the authors' 2014 study. This is somewhat striking given claims by ESCOs and other ESPC proponents that the projects perform better than direct-funded energy conservation projects due to the ESCOs' guarantees and associated M&V of the savings. It is important to identify that most ESPC projects rely not on whole-building meter-based M&V, but approaches that isolate the affected system or piece of equipment to evaluate the performance of individual ECMs (i.e., IPMVP Options A and B). Instead of a holistic M&V analysis, this M&V approach typically compares an individual ECM's pre- and post-energy consumption after adjusting for any changes to operating conditions. Most of the reported savings (almost 90%) in the over 180 active ESPC projects that have used FEMP's IDIQ contract employ this type of "retrofit isolation" M&V for evaluating their performance (Walker 2020).

This study aims to conduct a much quicker and less expensive comparison of the two project types, focusing on the effect of energy projects on the overall facility's energy consumption rather than *reported* savings. FEMP maintains a database of federal building energy performance, called the Compliance Tracking System (CTS). CTS documents the energy performance of all buildings that are characterized as "covered" under the Energy Independence and Security Act (EISA) of 2007, i.e., they account for 75% of each federal agency's total energy usage. CTS also describes the energy projects undertaken at the buildings, including their baseline energy consumption and estimated savings. Benchmarked performance of the buildings is also included in the CTS descriptions, generally calculated using the EPA's ENERGY STAR Portfolio Manager (ESPM). ESPM normalizes building energy consumption by factors such as size and weather, and other sector-relevant factors (for example, patient beds for hospitals or number of computers for office buildings). The ESPM normalized energy performance result is energy usage intensity (EUI), the ratio of a building's annual energy consumption to its gross square footage. In some cases, the EUI may be questionable when comparing one building to another, since all appropriate normalization factors are never identified. However, at a minimum EUI represents a valuable way to track a building's performance against itself over time.

In this study, we looked at buildings that had undergone energy conservation projects – whether conducted through ESPCs or directly funded – and tracked EUIs before and after each project. The change in EUI, ideally a savings, could then be compared to the *estimated* percentage savings for the energy conservation initiative to generate a rough realization rate. For any given building, the EUI change may result from any number of factors that might affect energy use. However, across a large enough portfolio size, building-specific factors should cancel each other out, such that a trustworthy savings realization rate can be established. In this study, the ESPC and direct-funded portfolio of buildings were sufficiently large (n>30) (Kiemele, Schmidt and Berdine 1997) that realization rates for the two could be established and compared.

In a world where urgency to achieve energy savings is great but funding short, purportedly "paid from savings" projects like ESPCs (along with related project models like efficiency-as-a-service (EaaS) and property assessed clean energy (PACE)) are intuitively attractive. But do these models really pay for themselves? How does their performance compare to conventionally funded (bid-to-specification or design-build) projects? An effort to properly decipher this, especially with sufficient sample sizes and "blind" evaluators, would be very expensive and time-consuming, and has not been conducted.

Method

We collected data exclusively from FEMP's Compliance Tracking System (CTS) database. The approach was largely the same for the ESPC and direct-funded projects. In order to assess the pre- and post-intervention change, we first filtered each portfolio set such that it included only buildings that had both two years of normalized EUI data prior to the initiation of the project and also two years of these scores *after* project acceptance. For instance, if a given project was initiated in 2015, we were looking for normalized EUI figures from 2013 and 2014; if the same project was accepted in 2016, we sought buildings with subsequent EUIs for at least 2017 and 2018.

We also applied two additional data cleaning rules. EUIs needed to fall between 10,000 and 500,000 Btu per square foot per year, as these represent typical bounds for very low and high building energy usage, outside of which we deemed the data dubious. Buildings with EUIs that were identical for more than two years were also discarded.

After the two data sets were scrubbed, we calculated estimated energy savings on a percentage basis for all projects by dividing the estimated total savings identified in CTS for each project (in MMBtu) by the annual usage prior to project completion. Calculated estimated percentage savings for the ESPC portfolio were cross-checked with ESCO-reported percentage savings provided in their project proposals. Unfortunately, data were not available for a comparable data check for the direct-funded projects.

Lastly, for the direct-funded projects (classified as "Direct centralized capital funding" (DCCF) in CTS), we applied a savings threshold of 2% of total building energy usage, eliminating buildings whose conservation projects were not estimated to deliver at least that amount of savings. This filter was applied in order to minimize the "signal-to-noise" effect, by which the ECM's savings are dwarfed by other factors influencing usage at the building. Ideally this threshold would be set even higher, especially given the fact that typical federal ESPCs, which usually have multiple ECMs, save much more (about 19%, on average). However, setting a higher savings threshold would have unduly limited the sample size of the direct-funded projects, which tend to be single-ECM interventions (and thus generally have much lower per-building savings).

After applying these criteria to the buildings in CTS, we were left with 22 ESPC projects covering 390 buildings and 24 direct-funded projects covering 57 buildings. Percentage improvement in weather-normalized EUI was calculated for each of the buildings in the two data sets (ESPCs and direct-funded projects). This EUI improvement resulted from comparing the average of the two years of EUI data prior to project completion and after. The EUI improvement, then, can reasonably be attributed to the energy project. Finally, the percentage change in EUI was divided by the project's energy savings on a percentage basis, which yielded an approximate realization rate.

There is one additional data constraint that should be highlighted. CTS documents estimated savings for federal energy conservation projects, most of which involve multiple buildings. These savings are not broken down separately by individual buildings. Where a conservation project applies to more than one building, as most ESPCs and many direct-funded projects in CTS do, our knowledge of the estimated savings represents only an average across *all* buildings included in the project. However, if all buildings covered in a project are included in CTS, the ratio of achieved to estimated savings across all those buildings should represent an accurate average realization rate for the project's buildings.

Because of this averaging of savings across buildings in a project, any individual building's results could be deceptive as a result of the variance of estimated savings from building to building. For instance, if there are three buildings with identical energy usage covered by a project (and all included in CTS) with 3%, 5%, and 7% estimated savings as ratio of baseline energy consumption, CTS reports only the 5% average. If the EUIs drop by 4% on average from before the project to after, the average realization rate for the buildings is 80% (4%/5%). However, again, it may well differ for any one of the individual buildings. The only instance when this data shortage could pose a distortion to the results is when all buildings covered by a project are *not* included in our data – *and* the ones we include are not representative of the overall project's savings percentage.

Sticking with our previous example, if only the buildings with 5% and 7% savings are in our data set (because, for example, the one with 3% savings was not among the "covered" buildings cataloged in CTS or didn't have two years of EUI data entered before the project's initiation), our data would indicate an estimated savings of 5%, the project's average. But our computed realization rate, given an 80% actual rate, would imply 4% savings at the first building (the one with an estimated savings of 5%) and a 5.6% savings at the second building (the one with an estimated savings of 7%), for a combined savings rate of 4.8%, rather than the project's true average savings rate of 4%, thereby yielding a realization rate of 96% (4.8%/5%). This potential distortion, assuming it is random and not systematic, should cancel out with larger numbers of buildings included in the study, especially if the majority of buildings included in projects are also included in CTS and represented in the study (i.e., not eliminated due to data cleaning).

Results

Based on the sample set of projects, the median realization rate – the ratio of the calculated performance (using normalized EUIs) to the estimated performance – was 105% for ESPC projects, while the median for direct-funded projects was 46%. However, the spread of the data for both project types was remarkably high. Hence, the difference between the realization rates between the populations was significant only at the $p < 0.2$ level. Figure 1 summarizes and compares the realization rates using box and whisker plots.

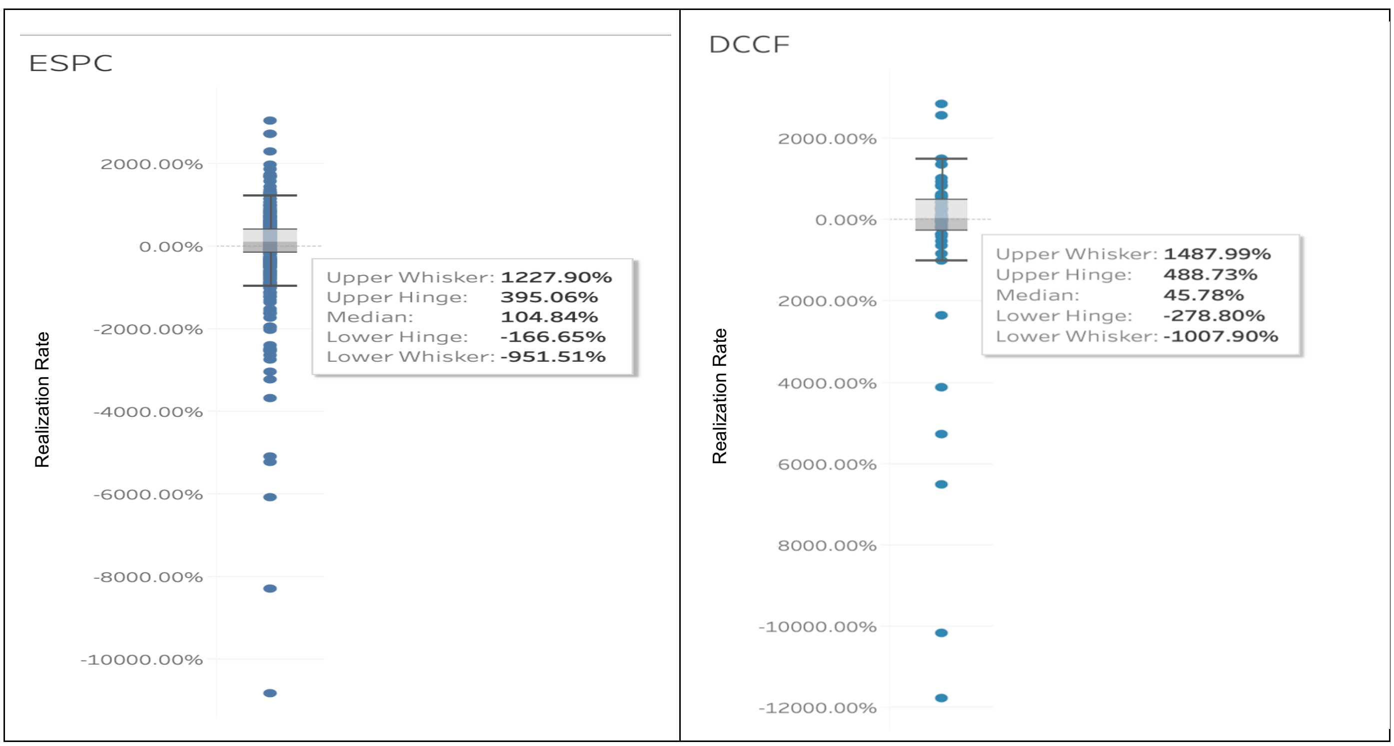

Figure 1: Bar and whisker plots showing the realization rates for buildings with ESPC projects (left), and direct funded projects ("direct centralized capital funding," DCCF).

For ESPC projects (on the left), the interquartile range of calculated savings realization ranged from -167% (25th percentile) to 395% (75th percentile). For direct-funded projects, the interquartile range was even larger, ranging from -279% to 489%.

Figures 2 and 3 show EUI changes compared to the estimated energy savings as a percentage of the baseline energy consumption for the ESPC and direct-funded projects, respectively. For example, project 94803, implemented on just one building, had an estimated savings of 4% (Figure 3). The weather-normalized EUI improvement for this building was found to be 9%, resulting in a project realization rate of 225% (9%/4%).

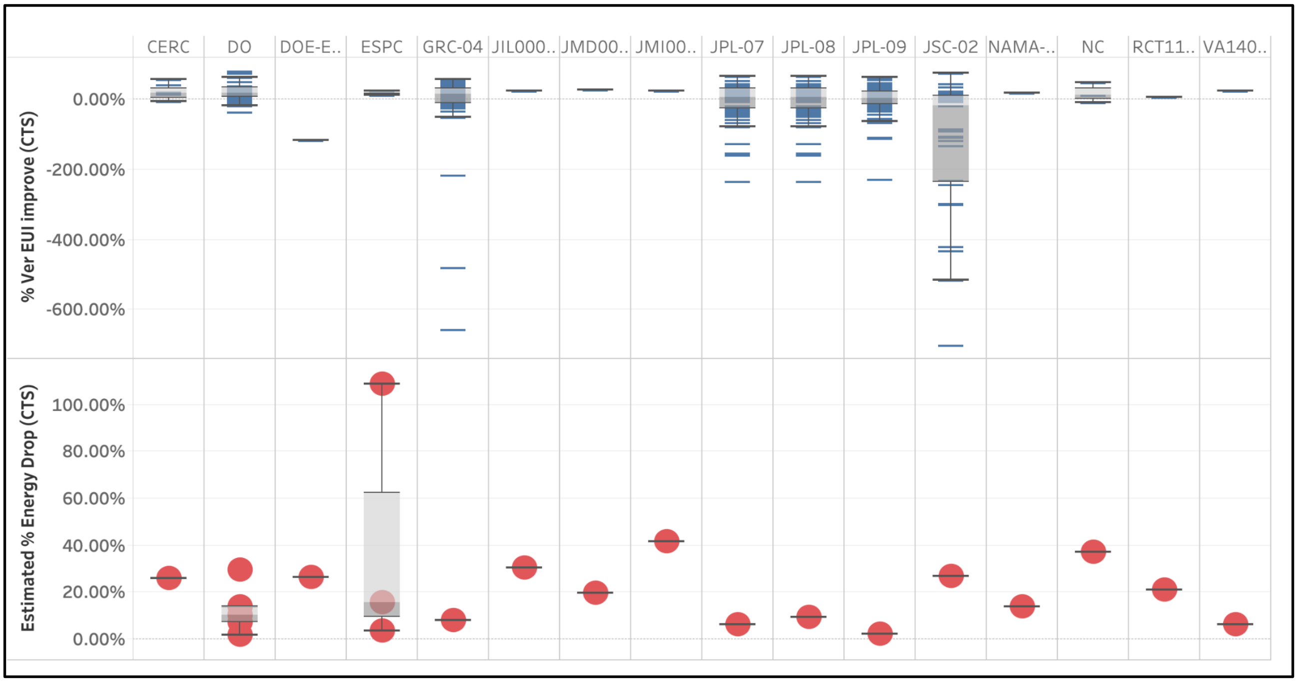

Figure 2: Bar and whisker plots showing the actual EUI performance of the ESPC buildings (top), with corresponding estimated energy savings as a percentage of baseline energy consumption (bottom).

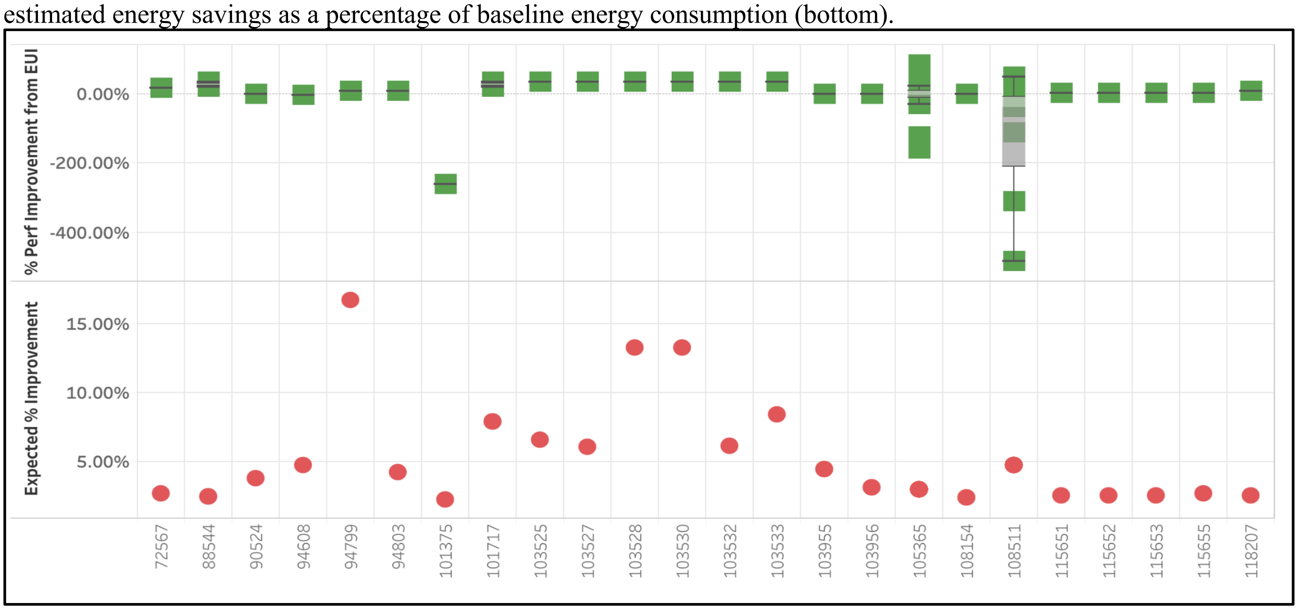

Figure 3: Bar and whisker plots showing actual EUI performance of the direct-funded project buildings (top), with corresponding estimated energy savings as a percentage of baseline energy consumption (bottom).

Discussion

The results indicate greater savings realization for the ESPC buildings (median = 105%) than for direct-funded projects (median = 46%). The results appear to be consistent with the findings from the authors' 2014 paper. That study also found a marked difference in reported realizations between the two project types (102% to 67%). The acknowledged weakness in the 2014 study was the different (and differently vested) actors in charge of the reporting – the ESCOs for the ESPCs versus federal employees and agency-hired O&M contractors for the direct-funded projects. This study avoided that shortcoming by using the results of a widely used building energy benchmarking system, ESPM, to assess savings realization for both project types. The savings realization for ESPC buildings was markedly higher, however, the difference between the two portfolios is significant at only an 80% confidence level (i.e., $p < .20$).

The ESPCs' higher savings realization is important, given the likely reliance on paid-from-savings models (ESPCs, EaaS, PACE, and others) to address existing buildings in the pursuit of mitigating climate change. But this study's results lacked sufficient statistical persuasiveness. So, what could resolve the issue, short of a multi-year, multi-million-dollar study comparing the *in-situ* savings results from large numbers of these projects? Conceivably, this study could be replicated within a few years when greater numbers of projects and buildings with meaningful CTS data will be available. There is an inherent problem, though, in that the naturally occurring "noise" in energy consumption data for a given building poses considerable difficulty in the direct-funded project population, where estimated savings from interventions are tiny – often on the order of just two to three percent of a building's baseline energy consumption – compared to those from ESPCs, where savings are on average almost an order of magnitude greater. This difference in magnitude of savings in relation to the baseline energy consumption adds additional uncertainty to the analysis.

There may be other methods to approach this problem, as well as other project databases to plumb. Nonetheless, the study's corroboration of the authors' 2014 paper revealing similarly greater savings realization rates from ESPCs compared to direct-funded projects offers an intriguing finding for policy makers.

This work focused solely on energy projects' savings (in order to assess savings realization rates) and did not include any analysis of project *costs*. So, for instance, perhaps savings realizations are substantially higher in ESPCs, but they cost more than direct-funded ones. An important and logical extension to this study would be to investigate how the implementation costs compare between the two project types. This cost analysis would ideally normalize for variations in the projects, including locations, ECM types, and implementation dates, to ensure that the comparisons are meaningful.

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