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ePproject Builder: Promoting wider adoption of energy savings performance contracts through standardization and transparency

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ABSTRACT

Energy savings performance contracting (ESPC) enables building owners to implement facility upgrades and reduce energy and water consumption (often with operations and maintenance expenses) using the resulting annual stream of cost savings to cover project installation and financing costs. The size of the international ESPC market is ~$30 billion per year and growing. However, ESPCs still face myriad barriers to achieving their market potential. Barriers include lack of data standardization and transparency, lost data, and inconsistent project performance monitoring. These barriers have limited stakeholders' ability to understand how projects perform. The inability to document and quantify past projects' success has led to skepticism, aversion, and unnecessarily high transaction costs. This work discusses a standardized approach to develop and document ESPCs through eProject Builder (ePB), which involves a simple Excel-based set of financial schedules combined with an on-line data archiving and tracking system. ePB enables standardized collection, calculation and reporting of project data in a way that promotes greater transparency of ESPCs to facility owners and other stakeholders. Specifically, the key benefits of ePB are that it (1) minimizes redundancies; (2) eliminates data inconsistencies resulting from multiple data repositories; (3) increases transparency by preserving and providing access to data in perpetuity; (4) enables development of "what if" scenarios; and (5) standardizes data to allow for comparative analysis of ESPC projects. Accordingly, ePB increases confidence in the ESPC vehicle among prospective customers. The paper demonstrates one key aspect of ePB's value by using it to conduct sensitivity analyses of key factors in hypothetical ESPC projects.

Keywords—ESPC, EPC, Performance Contracting

INTRODUCTION

Energy efficiency is a cost-effective strategy to reduce the operational costs of facilities and lower environmental impacts while also promoting economic growth. In addition to generating annual energy savings, investments in energy efficiency mitigate the need for some amount of generation, transmission, and distribution infrastructure that would otherwise be needed to keep pace with accelerating demand (McKinsey 2009). The International Energy Agency (IEA 2006) estimates that, on average, an additional one dollar spent on more efficient electrical equipment, appliances and buildings avoids more than two dollars in investment in electricity supply, which is particularly valuable in economies like India where lack of capital is a major issue. Further, investing in energy efficiency retrofit projects can generate significant returns for investors while minimizing their risk. According to some, energy efficiency projects can provide—on average —a 17% internal rate of return (McKinsey 2008).

Despite the high potential for energy efficiency to generate favorable returns, a significant number of barriers exist that hinder greater deployment of energy efficiency projects. Sorrell et al. (2000) compiled a list of barriers and categorized them as either economic, organizational, or behavioral. Economic barriers include: (1) limited access to up-front capital needed to implement many types of energy efficiency measures; (2) lack of data about past efficiency project performance, which could inform decision-making; and (3) uncertainty about whether a proposed project can provide sustainable long-term savings. Decisions based on incomplete or inaccurate information might result in cost-effective energy efficiency opportunities being missed or projects that may not realize the necessary savings.

A study conducted by Johnson Controls and the International Facility Management Association (IFMA) (Institute for Building Efficiency 2011), found that the barriers to energy efficiency in India are consistent with barriers in the United States: lack of technical expertise to identify retrofit opportunities; limited capital availability; uncertainty regarding projected energy and cost savings of proposed projects; and "insufficient" payback as decision-makers in India require a more rapid payback (often less than two years) (Delio et.al 2009) compared to a global average of 3.1 years (IFMA 2010). Despite these barriers, there is an enormous potential for energy savings in India—estimated at 183.5 billion kWh per year (Delio et.al 2009).

Energy service companies (ESCOs) engage in energy savings performance contracts (ESPC) as a key mechanism to help overcome barriers and promote investment in energy efficiency. ESPCs involve long-term contracts between customers and ESCOs that enable the customers to pay for energy retrofit projects with little to no up-front capital. ESPCs leverage private-sector financing dollars and enable the customers to pay for implementation of energy, water, and cost saving upgrades in existing facilities out of the multi-year stream of annual cost savings, which the ESCOs guarantee. Thus, the ESCO assumes some level of project performance risk, as specified in the performance contract. It should be noted that ESCOs provide a range of non performance-based energy services as well (e.g., construction bid-to-spec, fee-for-service, energy commodity procurement, consulting). However the literature generally defines ESCOs as companies that engage in performance-based projects as a core business and that assume some level of financial risk for those projects (Hopper et al 2007, Marino et al. 2010, Larsen et al. 2012). Delio et.al (2009) studied the ESCO industry in India and discovered that ESCOs there are classified into three categories: (1) a general ESCO (owned or operated by an equipment manufacturer or an energy supplier); (2) a vendor-driven ESCO (affiliated with an equipment or control manufacturer); and (3) a consultant ESCO (company that offers recommendations to a client based on knowledge or specialization). Eight ESCOs identified themselves as vendor-driven ESCOs, while 16 identified themselves as general ESCOs. No ESCOs classified themselves solely as consultants. The vendor-driven ESCOs earned 53% of the 2007 industry revenues. Ten of the 24 surveyed ESCOs indicated that they operated only through a guaranteed savings model; five operated only through a shared savings model (ESCO finances the projects and shares the operational savings with the customer) and the remainder used both.

ESCO INDUSTRY

The international ESCO industry market is growing quickly and now appears to be in the range of $30 billion per year (IEA 2017). ESCOs in North America and some Asian and European countries have been implementing performance-based energy efficiency projects in public- and private-sector facilities for nearly 30 years (Nakagami, 2010, Stuart et al. 2014, Bosa-Kiss et al. 2017). The U.S. ESCO industry has experienced significant growth from over most of the past two decades. In 2011, U.S. ESCOs reported aggregate industry revenue of about USD $5.3 billion, with expected growth to USD $7.6 billion by the end of 2014. IEA reports the 2017 U.S. market size as USD $7.6 billion (IEA 2019). Projects implemented by U.S. ESCOs save an amount equivalent to 1% of annual U.S. commercial building energy consumption each year (Carvallo et al. 2015).

Larsen et al. (2017) reported estimated remaining potential of the U.S. ESCO industry under two scenarios: (1) a base case, assuming current business and policy conditions, and (2) a case in which the market was unfettered by a number of existing market, bureaucratic, and regulatory barriers. The authors define remaining market potential as the aggregate amount of project investment that is technically possible for ESCOs to implement based on the types of projects that ESCOs have historically implemented in the institutional, commercial, and industrial sectors. The estimate draws on ESCO executives' estimates of current market penetration in those sectors. The authors estimate that the base case remaining market potential is USD $92–201 billion. They estimate a remaining potential of USD $190–333 billion under the unfettered scenario.

80–85% of U.S. ESCO industry revenue has consistently come from the public and institutional market (municipalities, universities, colleges, schools, state and federal government, and healthcare entities such as hospitals) [Stuart et al. 2017]. The federal government and nearly all states have enacted legislation that enables public sector facilities to enter into long-term performance contracts (up to 25 years in the federal sector and between 10 and 30 years in the state/local sectors). Such legislation, and associated government technical assistance programs, have been key drivers of ESCO industry growth (Carvallo et al. 2019). In other countries where ESCO markets have experienced significant growth (e.g., China and some EU countries), such growth has similarly been enabled by a range of supporting policies (Vine 2005; Bertoldi et al. 2006; Hopper et al. 2007, Marino et al. 2010; Duplessis et al. 2012; Yang 2016; Boza-Kiss et al. 2017).

The performance contracting market in China has grown dramatically, from USD $4 million in 2001 to USD $4.4 *billion* in 2010 (Kostka and Shin 2013), to $16.8 billion in 2017 (IEA 2019). Chinese ESCOs face challenging barriers and have barely begun to tap a tremendous technical ESPC market potential (Kostka and Shin, 2013). The European Union ESCO market has also experienced modest to significant growth for many of the member states in recent years (Bosa-Kiss et al. 2017).

India's ESCO industry is still nascent, even though the first three ESCOs were organized in the early 1990s (with funding from USAID). The Indian ESCO industry grew steadily and significantly after 2003 from a low base of less than INR 500 lakhs (USD $1.0 million) in 2003 to INR 8,640 lakhs (USD $17.7 million) in 2007 (Delio et.al 2009) and USD $300 million in 2017 (IEA 2019).

Obstacles for ESPCs

Despite steady growth over most of the past three decades, the U.S. ESCO industry has a long way to go to achieve its USD $100+ billion technical market potential. A range of market and institutional barriers continue to inhibit ESCOs and their customers (federal, state, and local agencies; educational institutions; and private commercial facility owners) from achieving the market potential and capturing the associated energy savings. A lack of data standardization, non-transparent approaches to project development, data losses over the term of a performance contract, and inconsistent project performance monitoring have limited stakeholders' ability to conduct timely analysis and accurate reporting of costs and savings to ultimately determine if the projects save money. This inability to document and quantify past projects' success has led to skepticism and unnecessarily high transaction costs, and in many cases, prevented proposed projects from moving forward. Some U.S. entities are actively calling for solutions to these barriers. For example, U.S. government audits critical of ESPC projects have recommended collecting and providing access to accurate data on these alternatively financed energy projects (e.g., see U.S. GAO, 2017).

Bhattacharjee et al. (2010) identified some of the barriers for implementing ESPC in the private sector and categorized them into four categories—market, institutional, financial, and technological. Ghosh et. al (2011) rank-ordered the barriers according to their importance, based on interviews conducted with staff at architecture, engineering and construction firms. The most critical barrier identified by the respondents was the lack of awareness about ESPC among the facility owners. Owners were not conscious about the energy efficiency potential of ESPC primarily due to information gaps, managerial disinclination, and lack of interest. Bhattacharjee et al. (2010) found that ambiguity between the owner and ESCO regarding realization rates of the estimated savings presented a barrier. The ambiguity relates to the credit risk, and perceived technical risk on the part of the facility owners, not only with regard to the savings realization of the measures, but also concerning the operating and maintenance risks for the installed equipment.

Financial barriers to increasing ESPC deployment include high transaction costs associated with paperwork requirements, and administrative and legal activities developing these contracts. These requirements can add costs to the project that the ESCOs may not be able to recuperate, so ESCOs may build in extra overhead to cover such transaction costs. For these reasons, as well as the savings guarantees they usually provide, ESPCs can be more costly per square foot than traditional design-bid-build type projects. Most private sector facility owners are not willing to pay the premium for ESCO-implemented projects compared to traditional design-bid-build type projects. Further, the private sector tends to focus its capital investments on implementing measures that have shorter payback periods (1–2 years) and that can meet specific internal rate-of-return requirements. Since they typically avoid implementing measures with longer payback times, they miss out on "deep savings" opportunities. Finally, the ESCO model's use of external financing presents another barrier to ESPC in the private sector. Financing energy efficiency might limit a private sector business owner's borrowing capacity that would otherwise be needed for funding the company's core business activities (Bhattacharjee et al. 2010).

Public Sector

The U.S. Department of Energy's Federal Energy Management Program (FEMP) and other federal, state, and local government agencies implement programs and disseminate tools, resources and training on ESPC. Despite these efforts, many stakeholders still consider ESPC to be cumbersome, unwieldy, and somewhat complex relative to traditional construction procurement processes. A survey conducted by Hopper et al (2005) found that the most often cited barrier to scaling up ESPC, particularly for the federal government, is the significant length of time it takes to develop projects (i.e., the time from when proposals are requested to contract signing with the ESCO). Most survey respondents indicated that ESPC project development times ranged from 12 to 24 months. This finding is consistent with another study (Hughes et al. 2003) that reported an average ESPC project development time of 14.9 months for projects initiated nearly 20 years ago. Another key barrier identified in the U.S. federal sector is the lack of appropriate and knowledgeable federal personnel to administer and manage these contracts through their entire life cycles, which may last as long as 25 years (GAO-15-432 2015).

The 1992 Energy Policy Act authorized the U.S. federal government to enter into long-term ESPC contracts (Congressional Research Service 2010). However, very few ESPC projects were initiated after its passage, due to extremely high transaction costs involved in negotiating every aspect of every contract. FEMP thus established the first indefinite delivery, indefinite quantity (IDIQ) contract vehicle in 1997. The IDIQ is a master contract that allows federal agencies to work with a prescribed set of pre-qualified ESCOs. The IDIQ contract has helped streamline

ESPC procurement to some degree; between 1997 and 2017, 37 agencies used the IDIQ to award 369 projects across all 50 U.S. states (FEMP, 2017).

Frequently cited barriers to broad use of ESPC in the municipal,state, university/college, K-12 schools and healthcare (MUSH) market sectors include:

- Complicated procurement process resulting in long project development time and high transaction costs
- Lack or loss of data for existing projects that are still under contract and being paid off (data losses are exacerbated by staff turnover through the performance period)
- Lack of data standardization and inability to conduct analysis on past projects, or to compare projects across ESCOs and market segments
- Inadequate data to make the business case for ESPC
- Inability to institutionalize knowledge about ESPC best practices (Dasek 2017)

International

Several studies (Vine 2005, Westling, 2003a, Westling, 2003b, Bertoldi et al., 2003, Biermann 2001, Singh 2010) have focused on identifying the barriers associated with ESPCs in an international context. While there are impediments that are unique to each country, several are common across different countries including:

- Lack of information and understanding of the opportunities that energy efficiency and ESPCs offer
- Public procurement rules for ESPCs are non-existent in most cases and highly complicated and burdensome administratively
- Limited understanding of energy efficiency and ESPCs by financial institutions results in less capital financing available for energy efficiency projects compared to traditional capital investments in the energy sector (e.g., power plants)

Furthermore, many energy efficiency projects are too small to attract the attention of large multilateral financial institutions. Finally, energy efficiency projects and ESPCs are perceived to be riskier than supply-side projects, because they are often non-asset-based investments with no tangible collateral.

E PROJECT BUILDER

The U.S. Department of Energy (DOE) recognized that public agencies and their ESCOs needed new tools to (1) transparently document ESCO pricing and savings estimates for these complex projects; (2) provide secure access to standardized data and long-term preservation of records in order to facilitate analysis and reporting of project performance over time; and (3) enable users to compare proposed projects against historical benchmarks by geography, ESCO, and market segment.

eProject Builder (ePB) is a system designed to address key barriers in order to increase the market potential for ESPCs. ePB is a secure, web-based data entry and tracking system for energy efficiency and on-site generation projects in the U.S. The project was developed and is maintained by Lawrence Berkeley National Laboratory (LBNL) with funding from DOE. ePB is composed of a simple Excel-based set of financial schedules combined with an online relational database and document archiving system.

More specifically, ePB allows ESCOs and their customers to:

- Develop project "what if" scenarios using standardized data and financial calculations. This feature enables the customer or ESCO to run financial scenarios based on various combinations of inputs to understand the cash flow implications of different project configurations.
- Easily manage, track, and report data on a portfolio of building retrofit projects—through the contract term and beyond.
- Preserve and quickly access project information, savings verification data, and additional documents in perpetuity.
- Generate project financial schedules, raw data for deeper analysis, and reports (tables, graphs) on project and portfolio performance. This feature allows customers to analyze project data across their portfolio of approved projects including a comparison of realized savings to projected savings.
- Use statistics generated from ePB to benchmark proposed projects against to improve customers' ability to evaluate the price reasonableness of proposals for a number of key metrics, such as annual M&V cost as a percentage of annual savings, and project development cost as a percentage of the total project implementation price. Such information will empower COs and other government stakeholders to properly evaluate the cost- competitiveness of a number of different contract types.
- Contribute to a growing national database of ESCO projects, allowing researchers to research key trends in this growing industry.

ePB comprises two main components: (1) a Microsoft Excel-based data upload template, which the ESCO populates and uploads to the online system; and (2) a web-based application where users upload and track their project financial metrics, estimated and guaranteed savings, verified measurement and verification (M&V) results, and other data.

Initial development of ePB involved extensive stakeholder input from FEMP, federal agencies, state agencies, and ESCOs on the types of information that would be most useful for ePB to collect and track. Over time, LBNL has updated this list of data fields and other features in response to requests from users.

During the first year after ePB's launch in 2014, FEMP, the DOE Office of Weatherization and Intergovernmental Programs (WIP), and the National Association of Energy Service Companies (NAESCO) embarked on a collaborative effort to promote the system to federal and state government officials. The effort included regularly scheduled introductory webinars, and customized presentations to teams (e.g., state officials and their pre-qualified ESCOs). Such presentations served both promotional and training purposes; seeing a full demonstration of the system helped potential users of the system understand first-hand how it worked, and, importantly, how it could benefit them.

Most of the initial projects entered into ePB were federal IDIQ projects as it was mandatory. However, ePB uptake ramped up slowly in the early years, particularly in the non-federal sectors. A few ESCOs in the federal sector immediately began using ePB in order to provide transparency and engender customer confidence in non Federal projects; however most ESCOs initially perceived ePB as a burden, rather than a value-added tool.

In order to gain industry acceptance, LBNL collaborated with its longtime partner, NAESCO. Since 2000, LBNL and NAESCO have collaborated on ESCO industry research. LBNL and the NAESCO leadership engaged with the ESCO industry on issues related to ePB over the course of two years. As a result, industry leaders ultimately endorsed ePB, and NAESCO requires that ESCOs applying for its national accreditation program, submit the requisite detailed project information into ePB.

The arrangement significantly impacted ePB uptake: from October 2018 through September 2019 the number of projects in ePB increased 73%, from 657 to 1,140. In addition, over time an increasing number of state government ESPC programs are requiring ePB, which further contributes to increasing uptake. Currently ePB contains 1,140 projects, representing total investment of US $9.6 billion and total contract guaranteed savings of US $17.7 billion. The database comprises 45% federal, 55% state, local and educational, and 5% private commercial/industrial projects.

The following section demonstrates the value for users in being able to develop sensitivity-based "what if" scenarios for their projects. We conduct a sensitivity analysis by plugging alternative assumptions into the Excel-based data upload template.

SENSITIVITY ANALYSIS

A number of financial metrics (e.g., contract term, net present value (NPV), internal rate of return (IRR) and payback time) are sensitive to key factors associated with an ESPC. These factors include (1) implementation price and interest rate; (2) recurring costs such as annual M&V and operation and maintenance (O&M) expenses; (3) energy and non-energy cost savings; (4) other factors such as utility escalation rates and payment frequency and timing. Some of these factors affect financial metrics more than others. It is important to understand the effects of these factors, so that a more informed decision on how to structure a project can be made. To illustrate sensitivities of different factors on ESPC cash flow, the authors elected to focus on NPV. NPV is computed from the stream of ESPC cash flows, using a discount rate to place greater value on near-term cash flows and relatively lesser value on those that are further in the future. We demonstrate the sensitivity analysis using a sample ESPC project. Key details are summarized in Table 1 below.

Table 1:Sample Project Details

ESPC PROJECT PARAMETER	BASE CASE ASSUMPTION	RANGE OF ALTERNATIVE ASSUMPTIONS
Total Amount Financed (Principal)	$6,460,167	
Discount Rate	5%	
Performance Period	10 years	
Study Period	25 years	
Project Interest Rate	5%	3.5%–6.5%
Escalation Rates	5%	3.5%–6.5%
Guarantee Percentage	90%	80%–100%
Year-1 Estimated Cost Savings	$871,698	

This table also indicates a few factors that are tested as part of this senstivity analysis, along with a range of values for each. The length of the contract is assumed to be 25 years, meaning the savings from the proposed ESPC would last for that time. The savings accrued in a given year by the customer is defined as the difference between the annual payments and the guaranteed costs savings. The NPV is applied on these savings over a period of 25 years with a discount rate of 5%.

Interest rates are, of course, one of the factors that can substantially affect the project financials and rate of return. Higher interest rates increase the total debt service paid over the term of the contract and therefore lower the NPV of the project. Lower borrowing costs allow for deeper energy savings by including additional measures with longer payback into a project that was not financially feasible with a higher interest rate. Interest rate depends on several factors including the credit worthiness of the ESCO and/or customer, risk profile of the project, rigor of M&V, and knowledge about ESPC from the lender. Some of these issues can be alleviated by adopting tools like ePB that offer increased transparency and standardization. Figure 1 shows the impact of interest rates on NPV for different payment options.

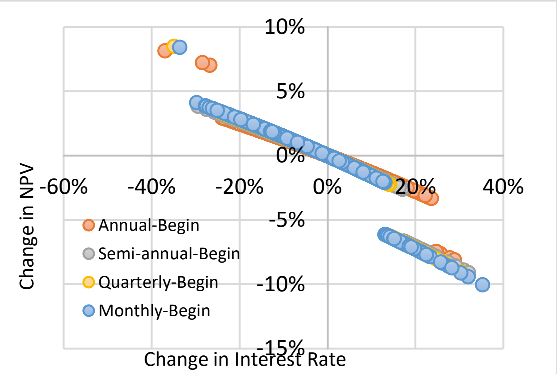

Figure 1: Project NPV as a function of interest rate.

As the interest rate increases, the NPV, for the project decreases underscoring that it is financially prudent to secure a low interest rate for ESPCs. The payment frequency and timing can also affect the NPV of the project (see Figure 2). An annual payment occurring at the beginning of the year tends to have the highest NPV, while the annual arrears payment has the lowest NPV. All of the other payment options have NPVs somewhere in between.

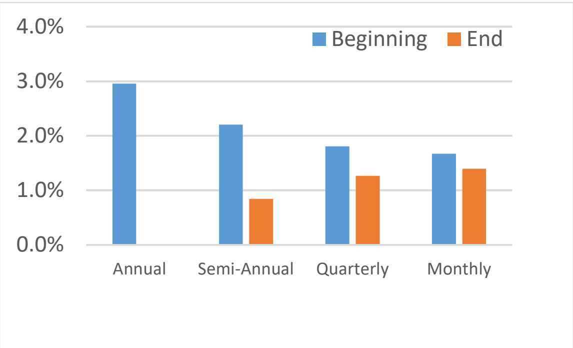

Figure 2: Effect in NPV of payment frequency and timing.

Escalation rates are applied to the utility (e.g., electricity) rates to determine the amount of monetary savings available from a project, given a guaranteed level of energy savings, to pay for the deal (i.e., its debt service and any project servicing costs, such as O&M or M&V). Financial metrics like NPV are extremely sensitive to the escalation rates. Choosing the optimal escalation rates is important, because selecting a rate that is less than the actual would be equivalent to leaving savings on the table and would result in paying more in total interest over the life of the contract than what is necessary. On the other hand, over-estimating escalation rates could mean that the project's monetary savings fall short of required payments

Figure 3 shows the impact of escalation rates on NPV for different payment options. As the escalation rates increase, the NPV for a guaranteed savings project increases almost proportionally, intimating that it is financially prudent to use a higher rate, assuming those rates are realistic/reasonable, which is a big unknown in any project. In the United States, the National Institute for Standards and Technology developed and manages an energy escalation rates calculator (EERC) that uses DOE's Energy Information Administration's energy prices (Coleman 2015). Because EIA has somewhat underestimated future energy prices in the recent past (since 2000), EERC estimates of escalation rates have been largely conservative, i.e., "safe" from the risk of over-escalation.

U.S. ESCOs generally do not guarantee all of their estimated savings, as a way to hedge against any project performance issues or errors related to savings estimation. For instance, ESCOs working with the federal government under DOE's umbrella ESPC contract on average guaranteed 92% of the estimated cost savings in their projects (Slattery 2018). Similar to escalation rates, setting this guarantee at an optimal level can be challenging. If this guarantee percentage is set too low, then both the guaranteed savings and the necessary payments to support those savings would be under-estimated. Lower payments would result in a longer contract term and in turn would incur higher debt service—and a lower NPV. On the other hand, setting this guarantee too aggressively can lead to a project that under-performs against the guaranteed level, thereby increasing the probability of a monetary shortfall that would have to be made up by the ESCO.

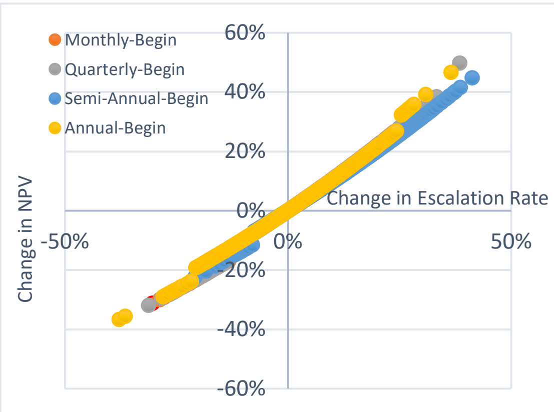

Figure 3: NPV as a function of escalation rate

Figure 4 shows the impact of guarantee percentage on NPV for different payment options. As the guarantee percentage increases, the NPV for a guaranteed savings project increases. It follows that it is financially prudent to use a higher guarantee percentage for ESPCs if the ESCOs are confident that they will be able to meet that level of performance. It should be noted that this guarantee percentage can be adjusted to account for the ESCO's risk tolerance, which is often based on the type of measures, complexity of the retrofit, and other factors.

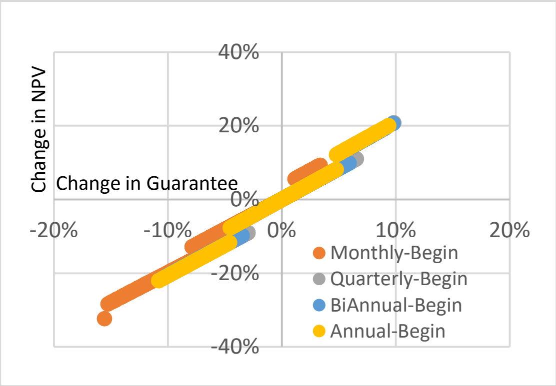

Figure 4: NPV as a function of percent of estimated savings that are guaranteed by the ESCO.

CONCLUSION

ESPC can provide an attractive, alternative financing mechanism in order to implement energy efficiency projects in India. These types of projects help customers reduce their energy consumption and associated costs with no up-front capital while containing some of the performance risks associated with the measures and project. However, there are many barriers that ESPCs face in India, including lack of credibility of ESCOs and the guaranteed savings model, lack of transparency and standardization among projects, and a general lack of the underlying data that documents the performance of these projects that can be used to value these projects for the lenders. This paper discusses eProject Builder, a web-based system that ESCOs and their customers can use to help develop and archive ESPC projects, as well as to track their performance throughout the project's performance period—and beyond. This tool also provides a transparent and standardized methodology to develop the amortization calculations to determine project financials, including payment schedules. It can be used to run financial scenarios based on various combinations of inputs to understand the cash flow implications of different project configurations. Also, ePB allows customers to compare proposed projects against benchmarks. The consistent and comprehensive collection of ESCO project data has important implications for the study of industry trends and best practices. Lessons learned from ESPC model in the United States are codified in tools such as ePB that may be useful to planners and policymakers in other countries like India where the ESCO industry is less mature. This tool provides a good framework for documenting and archiving aspects of ESPC projects, however some of the details may have to be customized and adapted to the Indian context to ensure that this tool aligns with the program requirements in India.

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REFERENCES

Bertoldi, P., Rezessy, S., Vine, E., 2006b. Energy service companies in European counties: current status and a strategy to foster their development, *Energy Policy*, 34, 1818-1832.

Bertoldi, P., Berrutto, V., Renzio, M., Adnot, J., Vine, E., 2003. How are EU ESCOs behaving and how to create a real ESCO market? Proceedings of the 2003 ECEEE Summer Study, European Council for an Energy-Efficient Economy, Paris, France, pp. 909–916.

Bhattacharjee, S., Ghosh, S., and Young-Corbett, D. (2010). Energy Service Performance Contracting in Construction: A Review of the Literature. Proceedings of the 46th Annual International Conference of Associated Schools of Construction, Boston, MA.

Biermann, A., 2001. ESCOs in the liberalised domestic UK energy markets—barriers to establishing ESCOs and possibilities to overcome them in the UK energy markets. Proceedings of the 2001 ECEEE Summer Study, European Council for an Energy- Efficient Economy, Paris, Vol. 2, France, pp. 437–446.

Booth, S., Doris, E., Knutson, D., & Regenthal, S. (2011). Using Revolving Loan Funds to Finance Energy Savings Performance Contracts in State and Local Agency Applications. Contract, 303, 275-3000.

Boza-Kiss Benigna, Bertoldi Paolo, Economidou Marina. 2017. Energy Service Companies in the EU - Status review and recommendations for further market development with a focus on Energy Performance Contracting, EUR 28716 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-71475-7, doi:10.2760/12258, JRC106624.

Carvallo, J., Larsen, P. and Goldman, C. (2015). Estimating customer electricity and fuel savings from projects installed by the US ESCO industry. Energy Efficiency, 8(6), pp.1251-1261.

Carvallo, J., Murphy, S., Stuart, E., Larsen, P. and Goldman, C. (2019). Evaluating project level investment trends for the U.S. ESCO industry: 1990–2017. Energy Policy, 130, pp.139-161.

Coleman, P. (2015). Escalation Rates in Energy Savings Performance Contracts. Energy Engineering, 112(5), pp.66-77.

Congressional Research Services. (2010). Identifying Incentives and Barriers to Federal Agencies Achieving Energy Efficiency and Greenhose Gas Reduction Targets.

Dasek, A. Energy Savings Performance Contracting in the Public Sector. [PowerPoint slides]. Retrieved September 26, 2017, from http://www.ncsl.org/Portals/1/Documents/energy/webinar_driving_economic_dev_A_Dasek_present_31485.pdf.

Delio, E., S. Lall, and C. Singh. 2010. Powering Up: The Investment Potential of Energy Service Companies in India. Washington, DC: World Resources Institute.

Duplessis, B., Adnot, J., Dupont, M., Racapé, F., 2012. An empirical typology of energy services based on a well-developed market: France. Energy Policy 45 (2012) 268–276.

Federal Energy Management Program (FEMP), 2017. FEMP Celebrates the 20th Anniversary of the DOE IDIQ Energy Savings Performance Contract (website).

GAO-15-432, Additional Actions Needed to Improve Federal Oversight, June 2015.

Ghosh, S., Young-Corbett, D. and Bhattacharjee, S. (2011). Barriers to the use of ESPC in the private building sector: perception of the A/E/C Commune. In: 47th ASC Annual International Conference Proceedings. Associated Schools of Construction.

Hopper N, Goldman C, Gilligan D, Singer, T. 2007. A Survey of the U.S. ESCO Industry: Market Growth and Development from 2000 to 2006. LBNL-62679.

Hopper, N., Goldman, C., McWilliams, J., Birr, D., and Stoughton, K. M. (2005). Public and Institutional Markets for ESCO Services: Comparing Programs, Practices and Performance (LBNL-55002), Ernest Orlando Lawrence Berkeley National Laboratory, Berkeley, CA.

Hughes, P., J. Shonder, T. Sharp, M. Madgett 2003. Evaluation of Federal Energy Savings Performance Contracting: Methodology for Comparing Processes and Costs of ESPC and Appropriations-Funded Energy Projects. ORNL/TM-2002/150. Oak Ridge National Laboratory.

Institute for Building Efficiency, Unlocking Energy Performance Contracting in India, 2011.

International Energy Agency (IEA). (2019). Energy Service Companies: At the heart of innovative financing models for efficiency

Johnson Controls and IFMA (2010). Global EnergyEfficiency Indicator 2010

Kostka, G., Shin, K. 2013. Energy conservation through energy service companies: empirical analysis from China. Energy Policy 52(2013)748-759.

Larsen P., Goldman C., Satchwell A. 2012. Evolution of the U.S. energy service company industry: market size and project performance from 1990-2008. Energy Policy 2012;50:802e20.

Larsen, P., Carvallo, J.P., Goldman, C., Murphy, S., Stuart, E. 2017. Updated Estimates of the Remaining Market Potential of the U.S. ESCO Industry. Lawrence Berkeley National Laboratory. April, 2017

Marino A, Bertoldi P, Rezessy S, Boza-Kiss B. 2010. A snapshot of the European energy service market in 2010 and policy recommendations to foster a further market development. Energy Policy 2011;39:6190e8.

McKinsey & Company, Unlocking Energy Efficiency in the U.S. Economy, Technical Report, McKinsey Global Energy and Materials, 2009.

McKinsey Global Institute, The case for investing in energy productivity, February 2008.

Nakagami, H., 2010. Recent Activity of the ESCO Industry in Japan & Asian Countries. Japan Association of Energy Service Companies. Presentation for the Asia ESCO Conference 2010. January.

Singh, Jas, D.R. Limaye, B. Henderson, and X. Shi. (2010). *Public Procurement of Energy Efficiency Services*. Washington, DC: The World Bank.

Slattery, B. (2018). Reported Energy and Cost Savings from the DOE ESPC Program: FY 2016

Sorrell, S et al. (2000), Barriers to energy efficiency in public and private organisations, Final Report from EC funded project, SPRU, University of Sussex

Soroye, K. and Nilsson, L. (2010). Building a business to close the efficiency gap: the Swedish ESCO Experience. Energy Efficiency, 3(3), pp.237-256.

Stuart, E., Carvallo, J.P., Larsen, P., Goldman, C. Gilligan, D. 2017. Understanding Recent Market Trends of the U.S. ESCO Industry. Energy Efficiency (2018) 11: 1303. https://doi.org/10.1007/s12053-018-9633-9

Stuart, E., Larsen, P., Goldman, C. and Gilligan, D. (2014). A method to estimate the size and remaining market potential of the U.S. ESCO (energy service company) industry. Energy, 77, pp.362-371.

Stuart, E., P. H. Larsen, J. P. Carvallo, C. A. Goldman, D. Gilligan. 2016. U.S. Energy Service Company (ESCO) Industry: Recent Market Trends. Electr. Markets & Policy Group, Lawrence Berkeley National Laboratory. LBNL-1006343

Vine, E. (2005). An international survey of the energy service company (ESCO) industry. Energy Policy, 33(5), pp.691-704.

Vine, E., Nakagami, H. and Murakoshi, C. (1999). The evolution of the US energy service company (ESCO) industry: from ESCO to Super ESCO. Energy, 24(6), pp.479-492.

Westling, H., 2003a. Performance contracting. Summary report from the IEA DSM Task X within the IEA DSM implementing agreement. International Energy Agency, Paris, France. France, pp. 1041–1047.

Westling, H., 2003b. Energy performance contracting will improve climate and business. Proceedings of the 2003 ECEEE Summer Study, European Council for an Energy-Efficient Economy, Paris, France, pp. 1041–1047.

World Energy Outlook 2006, International Energy Agency, 2006.

Yang, M. (2016). Energy service company and financial market development: experiences of the global environment facility. Mitigation and Adaptation Strategies for Global Change, 21, 663–676.