FREE Research Summary Series
Summer 2019

Foundation for Renewable Energy & Environment

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- The energy efficiency retrofit market is subject to trust concerns between parties. In particular, the ability of projects to deliver on promised savings is sometimes drawn into question.
- Energy saving performance guarantees are used to (partly) address this concern. These agreements have become the dominant risk mitigation tool used in the market.
- Methods that yield higher performance guarantees should, all else being equal, be able to advance the energy efficiency retrofit market.
- We explore the use of "automated controls" to extract higher performance guarantees.
- Our analysis finds that use of automated controls can significantly raise the performance guarantee, making projects more likely to succeed.

Risk mitigation in energy efficiency retrofit projects using automated monitoring and verification techniques

Performance gap concerns limit investment in the energy efficiency retrofit market. In particular, the ability of projects to deliver on promised energy savings is sometimes drawn into question. Performance risk mitigation mainly occurs through energy savings performance guarantees. Contractual stipulations arrange the conditions of the guarantee and, all else being equal, a higher energy savings guarantee should reduce project performance risk. Therefore, methods that yield a higher energy savings guarantee could help accelerate the market. We review the ability of 'smart', automated and connected technologies to: a) intelligently monitor and control the performance of energy-consuming devices to reduce performance variations; b) provide additional degrees of control over the project's performance and, by doing so, c) motivate the energy services company (ESCO) to raise the energy savings guarantee. Our analysis finds that use of such automated performance control could significantly raise the energy savings guarantee, making projects more likely to succeed.

FREE research staff worked on this project in collaboration with the Center for Energy and Environmental Policy (CEEP, University of Delaware). Exhaustive research results are accessible via the two following publications:

- Byrne, J., Taminiau, J., Carretero, D., Shin, S., and Xu, J. (2019). Risk mitigation in energy efficiency retrofit projects using automated monitoring and verification techniques. Technical report prepared for the Delaware General Assembly. Newark, DE: CEEP, University of Delaware.
- Taminiau, J., Byrne, J., Carretero, D., Shin, S., and Xu, J. (forthcoming). Risk mitigation in energy efficiency retrofit projects using automated performance control. Climate Risks and Energy Investments – Technical, Market, and Policy Innovations. ISBN 978-1-83880-198-4.

Causes and Risks Surrounding Energy Savings Project Performance Variation

There is concern regarding performance uncertainty, captured in the extant literature as an energy savings "credibility gap" or "performance gap". Expected or experienced manifestation of resulting performance risk leads some project clients to emphasize concern "about ESCOs guaranteed savings not being achieved, causing problems to third party financing". [1] In a similar vein, "uncertainty of payments based on savings" is listed as a key market and financial barrier according to a survey of industry professionals and scholars. [2] Yet, investment at scale is available when performance can be guaranteed.[3]

There is a general consensus in the literature that building controls can improve energy saving profiles of energy efficiency projects. Control of building operations could save up to 60% in energy consumption, with most savings reported in the 10%-30% range. [4] When controls are present to avoid low performance, (frequent) re-tuning of these controls is necessary over the lifetime of the project if the controls are not automated (or 'smart') to maintain desired performance.

Automated building control techniques can yield actionable value by monitoring and correcting, in real-time, the energy performance profile of the project. [5] In a general sense, these technologies are described as relying on "web-based analysis software, data acquisition hardware, and communication systems […] to store, analyze, and display whole-building, system-level, or equipment-level energy use" and, at minimum, provide hourly but typically

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provide sub-hourly interval meter data with graphical and analytical capabilities and assessment. [6]

The Energy Savings Performance Guarantee Setting Process

Realized savings can deviate from the guarantee. For example, review of a large database finds that 72% of projects experienced greater savings than were guaranteed by the ESCO (517 projects experienced such a mismatch between realized savings and guaranteed savings) – some by as much as 50% more. [7] This deviation is partly explained by the fact that, to limit their downside risk exposure, ESCOs typically set the guarantee below predicted performance using ESCO-specific risk tolerances.

Strategic guarantee placement can be modelled using stochastic performance profiles. [8] Stochastic performance profiles for hypothetical projects with and without the use of smart controls are used to quantify the ability of these technologies to increase the guarantee.

Guarantee placement design is dependent on project-specific dimensions and risks. A simplified version of this dynamic is represented in Figure 1. The figure shows that a project's savings can exceed a low guarantee but will likely fall short when a (very) high guarantee is used.

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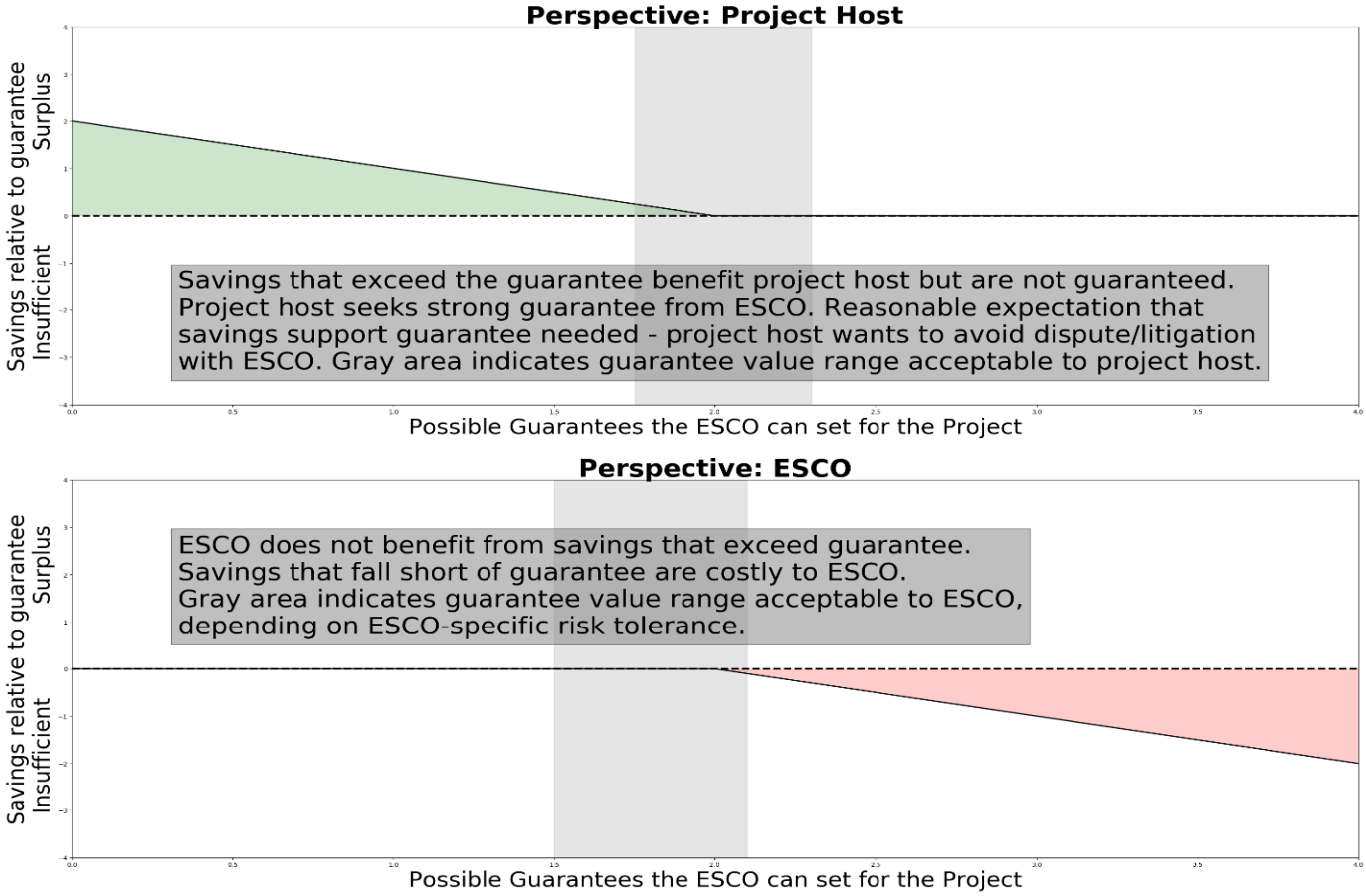

Figure 1 *Overview of the owner-ESCO decision-making process regarding setting the energy savings guarantee.* [9]

Modelling the Contribution of Controls in the Savings Guarantee Placement Process

The savings profile of the hypothetical project modeled in this project, for the benchmark "large office" building model from the United States Department of Energy (DOE), is such that, under highly unfavorable circumstances, the project could experience a broad range of possible savings (Figure 2). The performance of the post-retrofit building simulation without use of controls can be compared

[9] Byrne, J., Taminiau, J., Carretero, D., Shin, S., and Xu, J. (2019). Risk mitigation in energy efficiency retrofit projects using automated monitoring and verification techniques. Technical report prepared for the Delaware General Assembly. Newark, DE: CEEP, University of Delaware.

against the performance of the same model with the use of controls. As Figure 1 shows, the application of performance variation controls substantially improves the project, in terms of predictability, risk, and higher average savings overall.

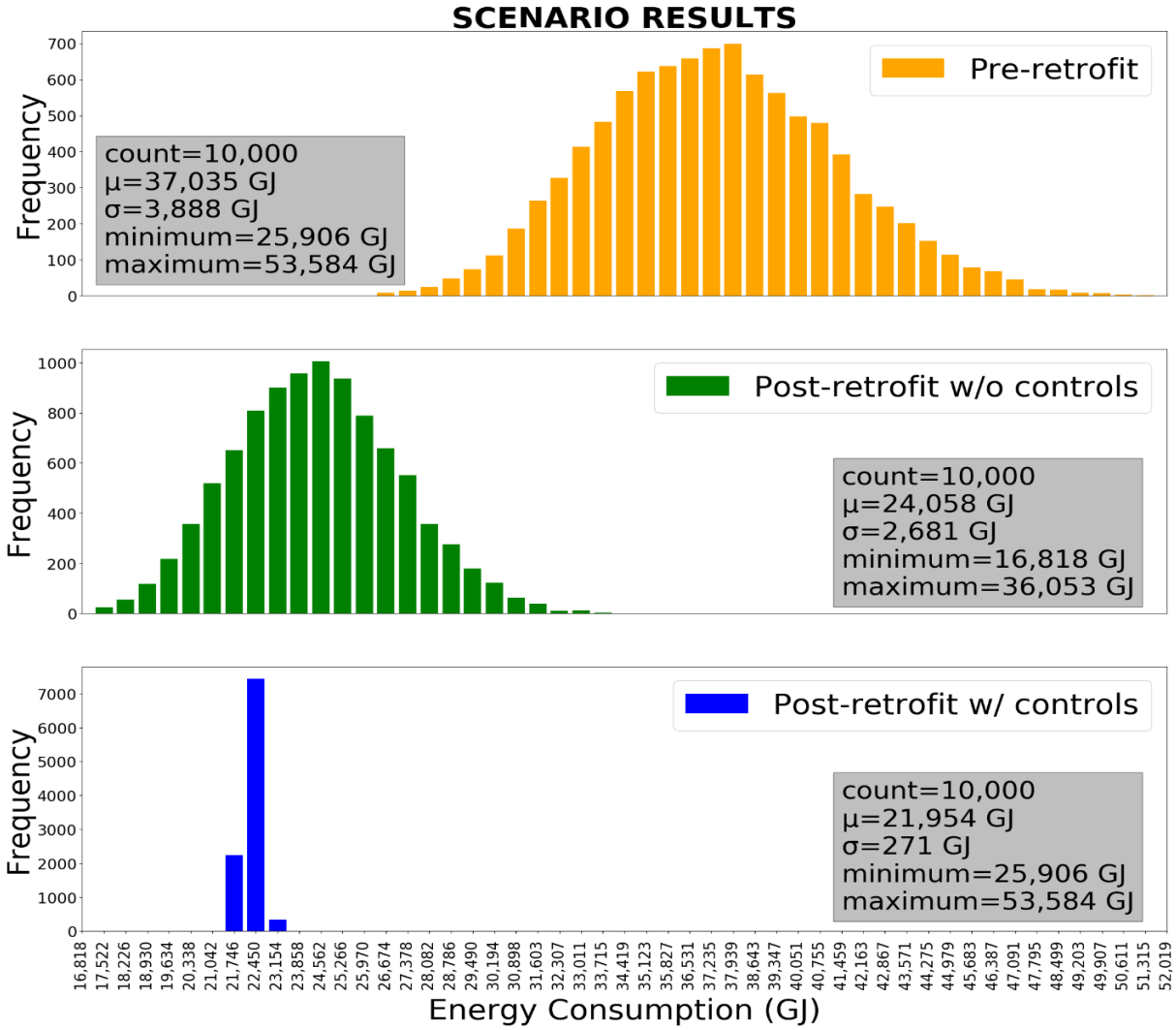

Figure 2 *Pre-and post-retrofit energy consumption without and with performance controls (10,000 simulations each) for the large office building.* [10]

[10] *Byrne, J., Taminiau, J., Carretero, D., Shin, S., and Xu, J. (2019). Risk mitigation in energy efficiency retrofit projects using automated monitoring and verification techniques. Technical report prepared for the Delaware General Assembly. Newark, DE: CEEP, University of Delaware.*

These two simulations could be used to determine the placement of the energy savings guarantee. Using the guarantee placement model built for this report, the cost savings profile of the hypothetical project yields a strategic guarantee estimate that is significantly higher in the scenario where automated controls are in effect (Figure 3). In a project without controls, the guarantee under the assumptions and model approach used in this project, would support a guarantee at ~$47,500 and smart controls improves the project's profile in such a way that a $116,000 guarantee becomes feasible.

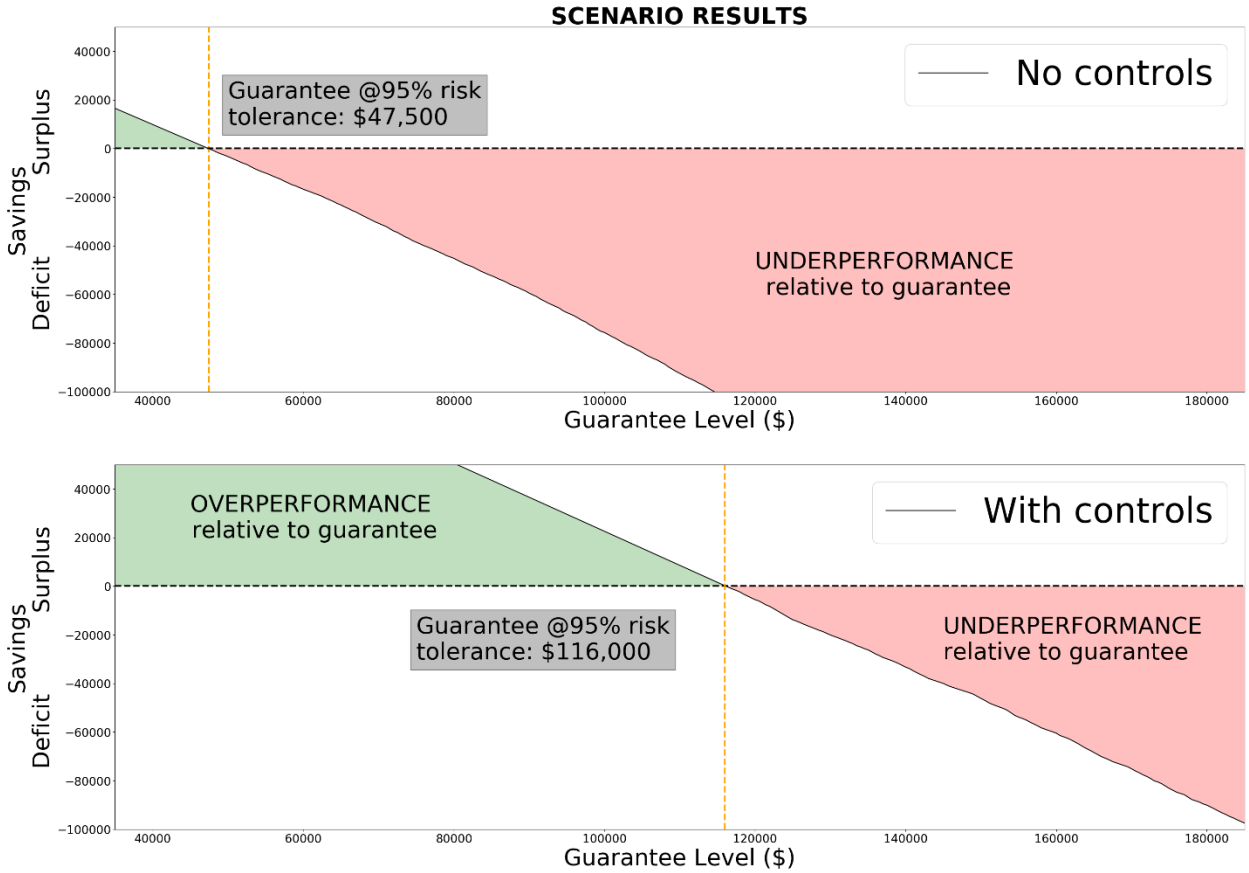

Figure 3 *Guarantee placement with and without controls for the large office building.* [11]

[11] *Byrne, J., Taminiau, J., Carretero, D., Shin, S., and Xu, J. (2019). Risk mitigation in energy efficiency retrofit projects using automated monitoring and verification techniques. Technical report prepared for the Delaware General Assembly. Newark, DE: CEEP, University of Delaware.*

Concluding Remarks

The conceptual and modeling approach introduced and tested in this research project targets project performance uncertainty – a dimension commonly neglected in energy savings calculations. The use of smart controls provides a potential avenue to accelerate investment in the energy efficiency retrofit sector by making project return more predictable. The uncertainty of a project is transformed into metrics legible for conventional risk management strategies. The resulting higher savings guarantee can be attractive to all parties involved, including the client and the third-party investor.

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The Research Summary Series is drafted by the FREE research team (http://freefutures.org/about/free-team/free-research-team/). For more information, contact FREE Research Principal Dr. Job Taminiau (jt@freefutures.org).

Please use the original research products for citation:

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