



2014 ASHRAE/IBPSA-USA

Building Simulation
Conference

Model Projections versus Measured Energy Savings in a Large Scale Incentive Program

Pay for Performance Program Overview

- Targets existing commercial, industrial, and multifamily buildings with annual peak demand of 100kW or more located in New Jersey
- Requires projects to install measures that reduce overall source energy consumption by at least 15%
- Relies on a network of approved providers who are recruited through continuous open enrolment and include engineering consulting firms, ESCOs, and other trades with demonstrated experience in energy efficiency projects

Incentive Structure

- Incentive #1 is paid upon approval of the Energy Reduction Plan (ERP), which documents projected energy savings from the proposed retrofit based on the calibrated simulation, and is proportional to the project floor area
- Incentive #2 is paid upon installation of the recommended measures, and is proportional to the energy savings projected in the ERP
- Incentive #3 is paid twelve months after installation upon verification of achieved savings following IPM&VP Option C: Whole Building Comparison
- Incentive #2 and #3 are designed as a single performance payment that is split in order to provide up-front financial assistance to install the measures. Incentive #3 is “trued-up” based on the actual achieved savings, so that the total performance incentive (i.e. #2 and #3) reflects the Program’s incentive structure.

Study Goals

Compare model projections to realized post-retrofit savings of participating projects in order to:

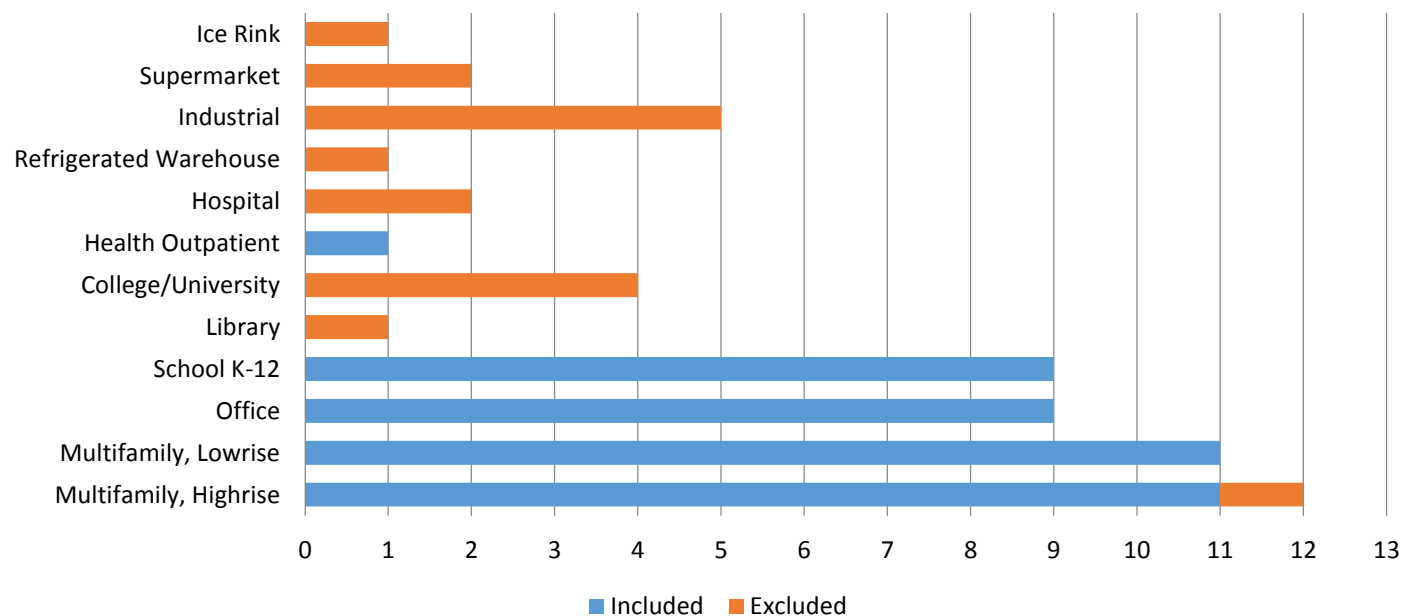
- Identify patterns affecting the accuracy of projections
- Inform incentive program design
- Inform submittal review strategies

Possible Sources of Discrepancy between Projected and Realized Savings

- **Site Data Collection Issues**
 - ✓ Fragmented project teams with different companies doing site work, modeling, installation, and site inspections
 - ✓ Site data difficult to obtain and measure, including pre-retrofit conditions for components affected by ECMs
- **Energy Modeling Issues**
 - ✓ Insufficient qualifications of energy modelers
 - ✓ Inadequate analysis methods (e.g. simulation tool limitations) and use of external calculations
 - ✓ Presence of complex measures, such as HVAC controls, which are difficult to model and often require the use of assumptions
 - ✓ Projects involving complex building types (e.g. hospitals) or with significant contribution of process loads (e.g. industrial projects)
 - ✓ Systems that cannot be directly modeled, such as steam heating / distribution
 - ✓ Quality of model calibration (e.g. misc. plug load/fan power underestimated and lighting use overestimated in calibration)
- **Measure Installation / Maintenance Issues**
 - ✓ Modeled systems / equipment are not properly installed
 - ✓ Modeled systems / equipment are not properly operated
 - ✓ Buildings with energy managers and/or EMS vs. those without (i.e. the ability to monitor performance internally)
- **Uncertainty in Determining Realized Savings**
 - ✓ Unreliable/missing utility bills
 - ✓ Unreported changes in building operation (e.g. increased / reduced vacancy rates, change in number of shifts, etc.)
 - ✓ Difficulty normalizing pre/post consumption for changes unrelated to the retrofit
 - ✓ Occupant behavior

Data Set

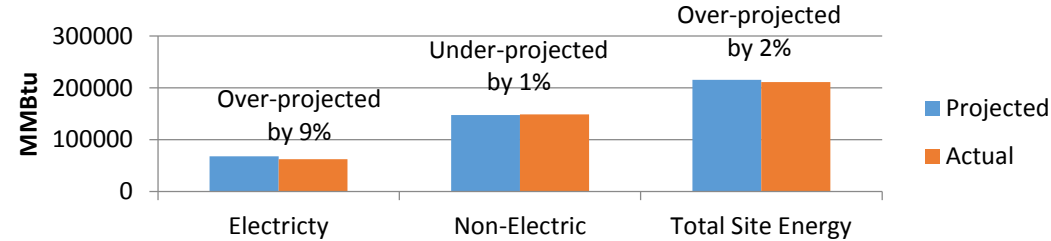
- All projects that submitted annual post-retrofit utility bills were initially analyzed
- Some projects were removed from the sample due to the following reasons:
 - known operational changes unrelated to the retrofit
 - projects where pre/post usage was likely affected by factors other than the retrofit and weather (e.g. production volume)
 - unknown pre/post-retrofit consumption of some fuels (e.g. projects using campus steam that are not sub-metered)



	All Projects	Selected Sample
Projects	59	41
Companies	21	16
Simulation tools	4	3
Building types	12	5

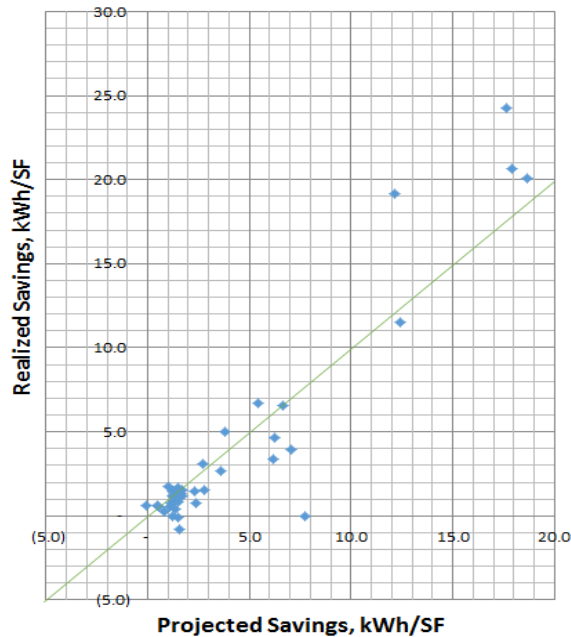
Projected versus Realized Savings: Overall Trends

Total Projected versus Realized Savings

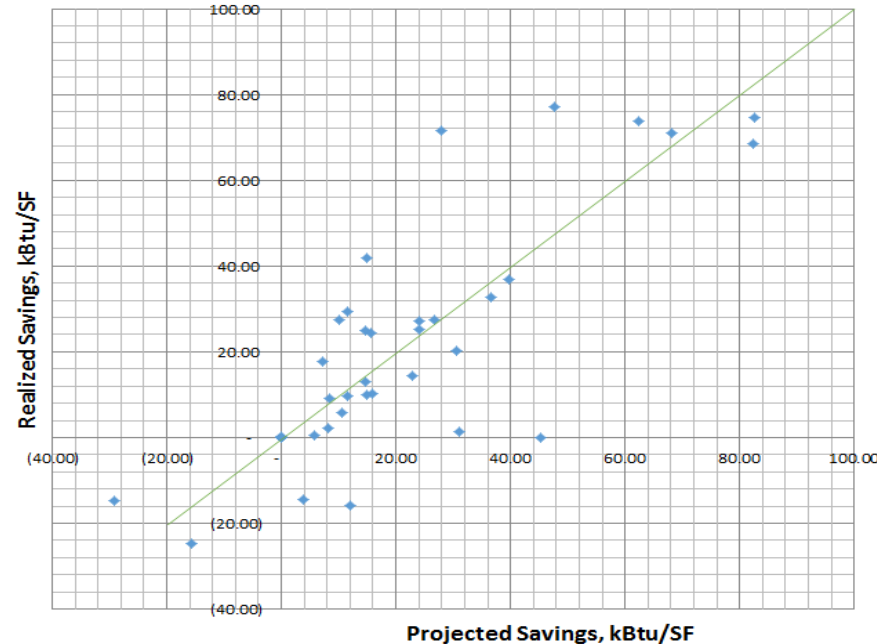


- The sum of projected savings and realized savings for all projects are very close
- There is a significant discrepancy in result for individual projects. Only 39% of projects have projected savings within +/- 20% of realized

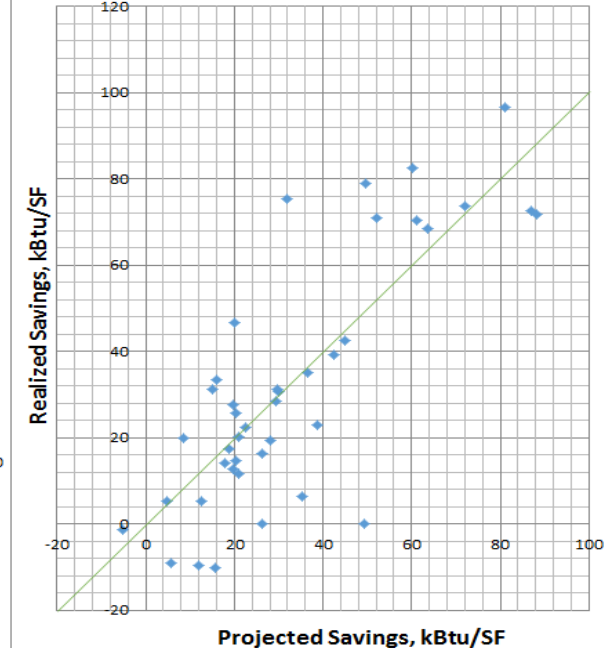
Annual Electricity Savings



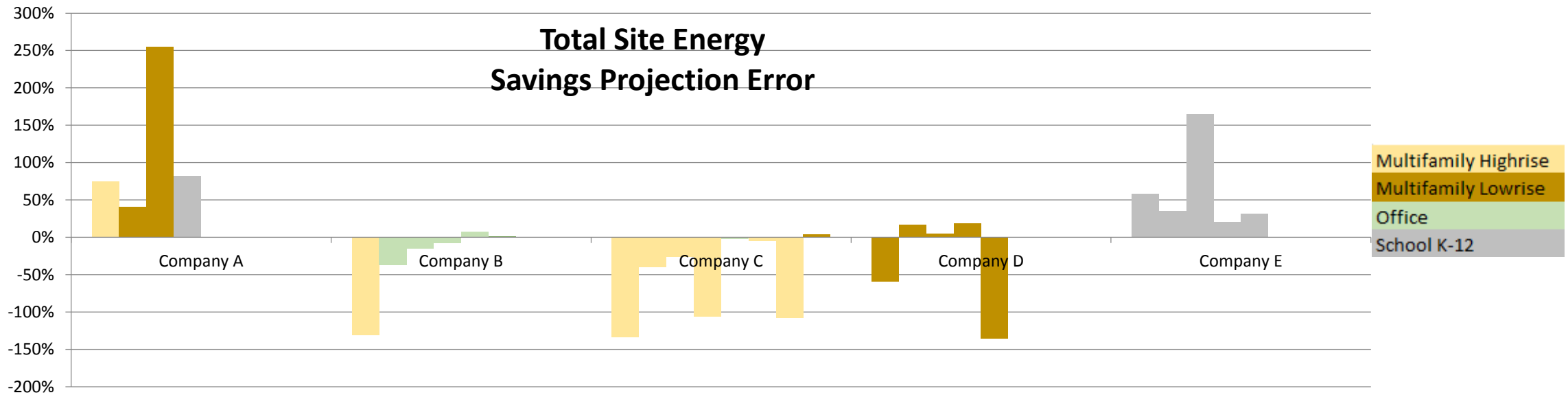
Annual Non-electric Savings



Annual Site Energy Savings

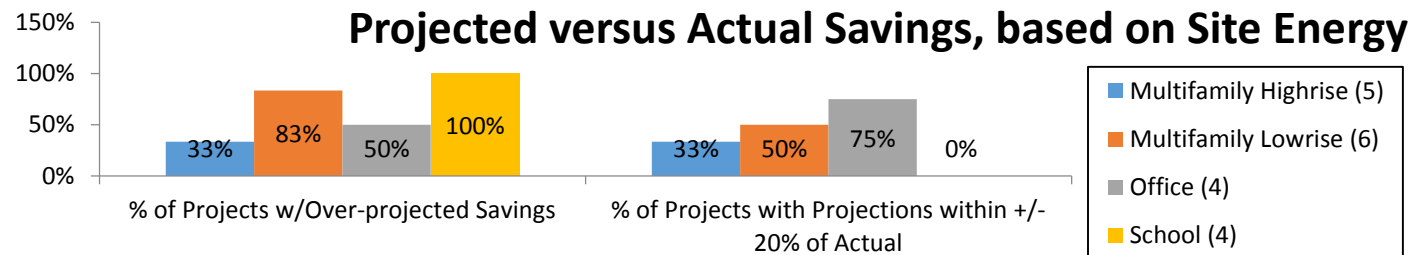
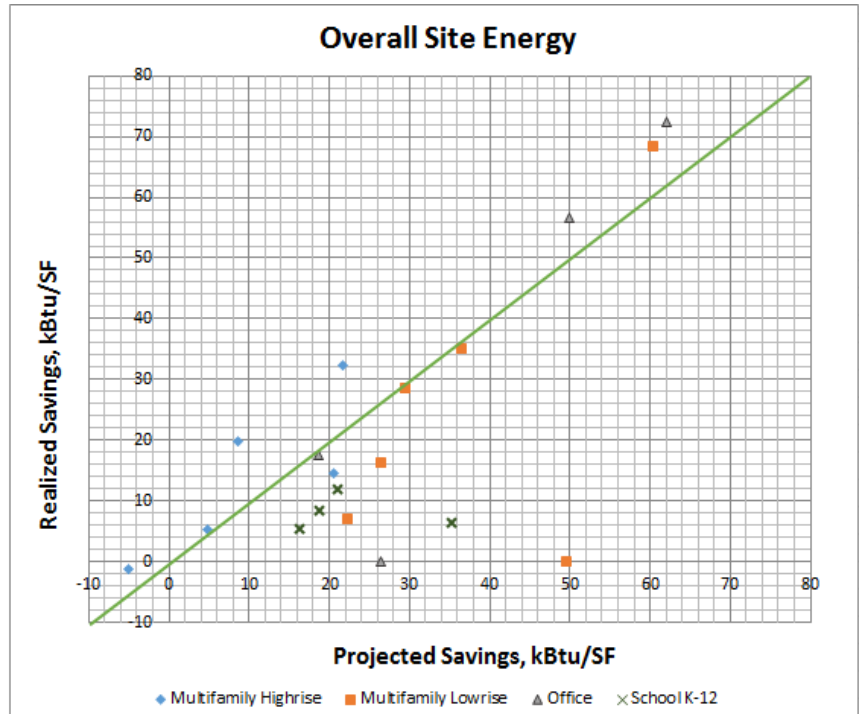
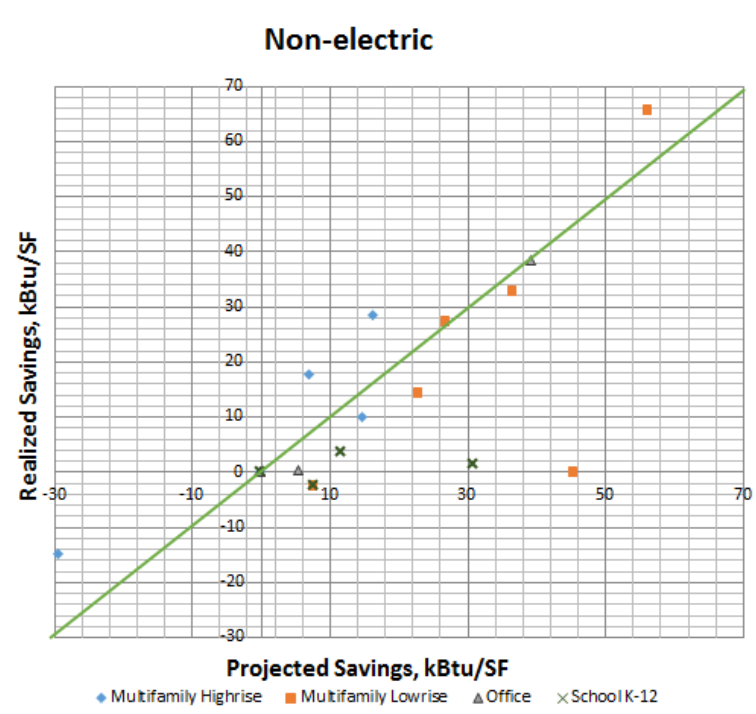
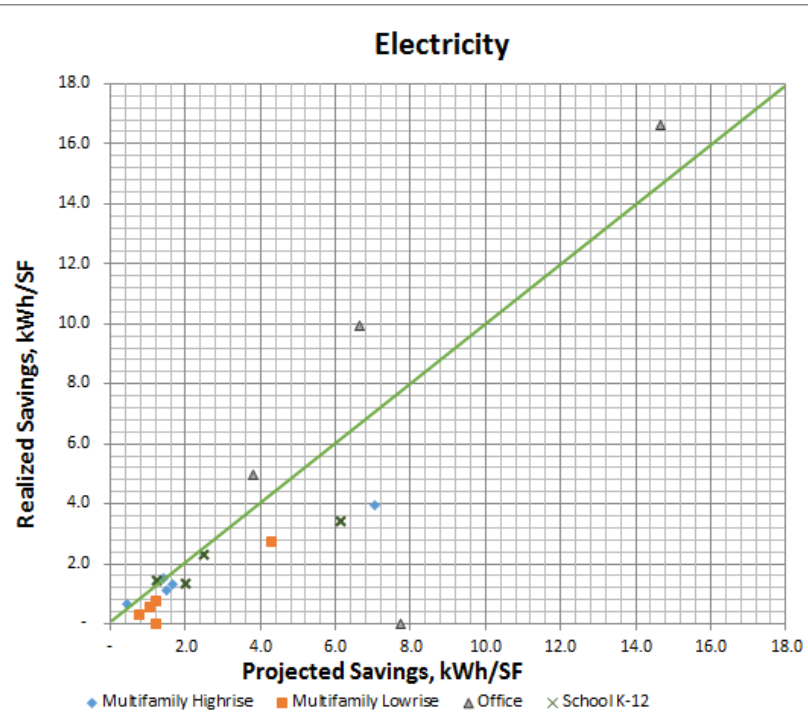


Trends by Company



- Included companies that submitted ERPs for at least 4 projects
- $\text{Projection Error} = (\text{Projected} - \text{Actual}) / \text{Projected}$
- Negative value indicates the savings were under-projected
- Positive value indicates the savings were over-projected
- Clear under/over projection trends by company

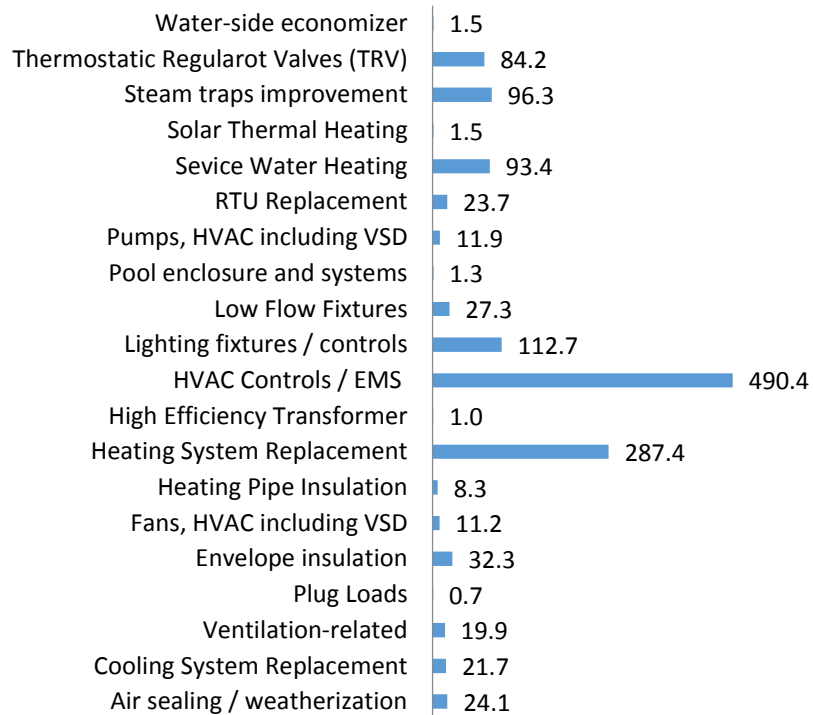
Trends by Building Type



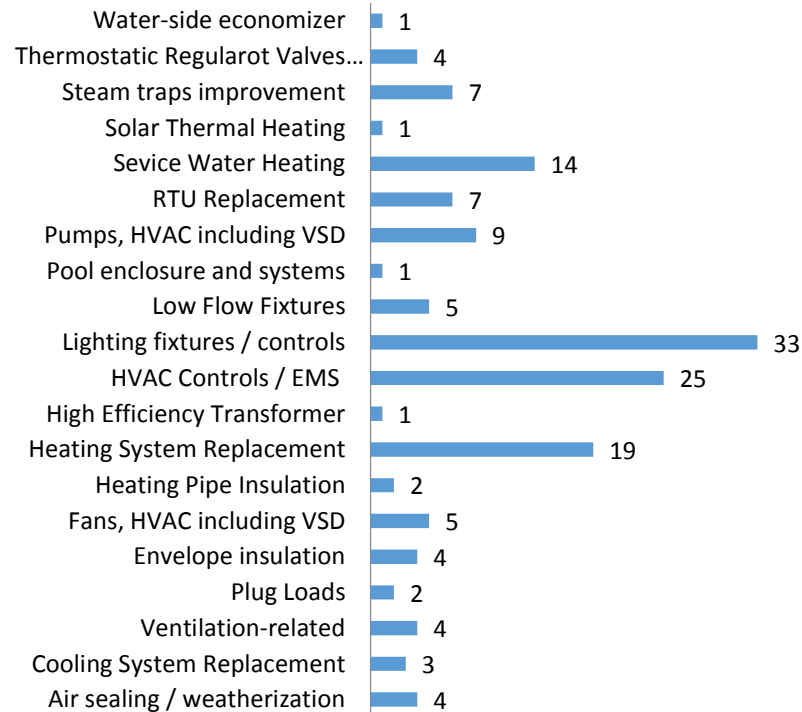
- Office retrofits had much higher electricity savings per unit area than multifamily and schools
- Low-rise multifamily had much higher non-electric savings per unit area than high-rise multifamily, office, and schools
- Overall site energy savings were much higher in office and low rise multifamily retrofits than in schools and high-rise multifamily

Measure Occurrence

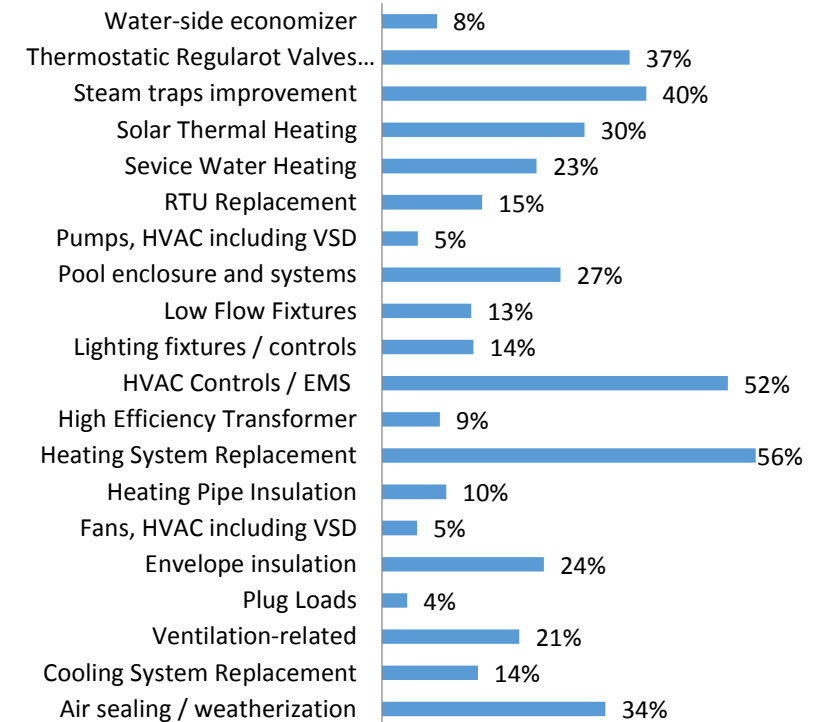
**Total Site Energy Savings MMBtu
by Measure Type**



**Number of Projects with
Measure**



**Average Contribution Toward
Site Energy Savings (if present)**



- ✓ HVAC Controls / EMS and Heating System Replacement measures account for the largest share of projected program-wide savings, and have significant impact on projected savings of individual projects, if present
- ✓ Lighting measure are the most common, but there contribution toward savings of individual projects is not as high

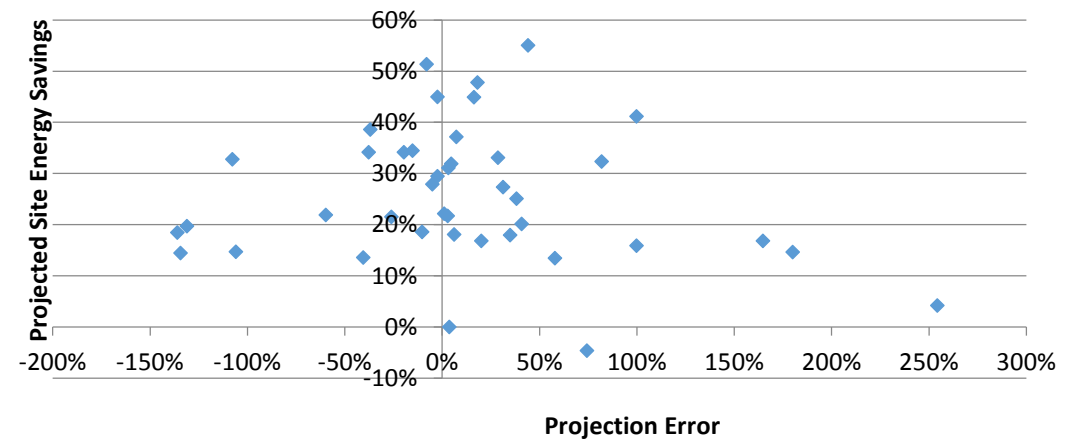
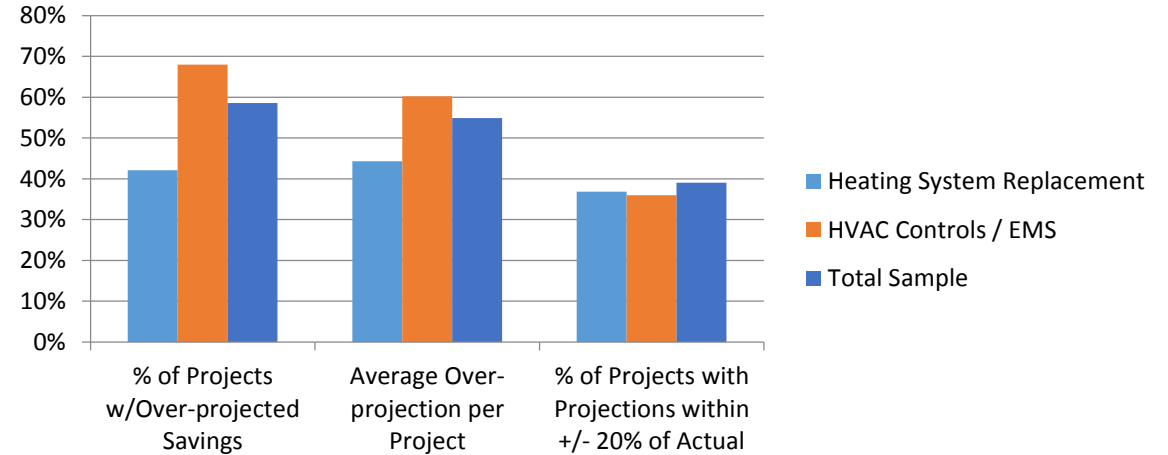
Other Trends

- **By Measure Type**

- ✓ Projects with HVAC Control / EMS measures tend to have higher over-projection than the general population
- ✓ Projects with Heating Replacement ECM tend to have lower over-projection than the general population
- ✓ Projects had 2-10 measures, with an average of 4.5 measures per project, making it difficult to isolate impact of individual measures

- **By Magnitude of Projected Savings**

- ✓ No correlation between magnitude of projected savings and projection error



Next Steps

- Revisit the analysis after more projects submit post-construction reports
- Examine projects with most accurate projections to formulate best practices
- Examine projects with the highest projection error to understand contributing factors
- Refine analysis methods for higher statistical rigor
- Share findings with program participants (e.g. consulting firms)
- Reach out to participants that consistently under/over-project savings
- Continue using incentive structure that relies on combination of the projected and realized savings, to ensure accountability and fairness in distribution of funding

Questions?

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