

# Power, Power Factor, and Engineering Uncertainty

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## Uncertainty in Measurement

Energy program evaluators routinely use statistical measures of uncertainty to determine appropriate sample sizes. Lately, more attention has been paid to engineering uncertainty as well. With quantified estimates of both statistical and engineering uncertainty, designers can make informed choices regarding sample size and engineering spending per project to minimize overall uncertainty and bias subject to cost constraints. When planning how to measure the impact of a particular project, the engineer must decide what approach to use to minimize overall uncertainty. Monte Carlo simulation-based methods are being used to inform this decision.

## Measuring Power

One particular choice engineers frequently face is whether to measure amperage and estimate real power or, at additional cost, measure real power directly. Is the extra cost of real power metering a good investment, or is that money better spent reducing uncertainty of another engineering parameter at the site, or better spent lowering the overall site engineering cost so sample size can be increased? Historically the site engineer has based this decision on intuitive engineering judgment.

## Methods

This poster identifies potential bias in estimating power factor and presents a technique to minimize error and bias associated with estimating real power from current. It also provides the results of analysis that planners can use to predict the uncertainty associated with this and other power measurement methods. These results will improve the accuracy of Monte Carlo simulation and similar engineering uncertainty analysis.

## Exhibits

- Power factor as a function of load, scatter of all TEFC & ODP motors & curve fit.
- Power factor as a function of load and HP, curve fits.
- Efficiency as a function of load and HP, curve fits.
- Table of standard deviation (for engineers) and precision at 10% confidence level (for statistics) with various levels of unknowns, if various parameters (like horsepower) are known.
- Summary of cost per data point for measuring real power vs. using amps as a proxy.