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MODULE

11

Using Statistics to Communicate Uncertainty

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Uncertainty in measurement and verification (M&V) is crucial for determining the reliability and accuracy of results. It can arise from various sources, such as instrument limitations, environmental conditions, and operator error. Effective communication of uncertainty is essential for stakeholders to make informed decisions based on measurement data.

Learning Objectives

- Introduction and Course Outline
- Contexts and Concepts: The M&V Specialist's Function
- Standards of Practice
- Practical Considerations for M&V
- Physical and statistical models
- System boundary in M&V
- Baseline: Additional Considerations
- Special Baseline Considerations for Utility Programs
- Implementing the baseline model and data from the reporting period
- Granularity and load shapes
- Using Statistics to Communicate Uncertainty



INTRODUCTION

- Uncertainty in measurement can be systematic or random.
- Systematic uncertainty arises from consistent biases in measurement, such as calibration errors or environmental influences.
- Random uncertainty is caused by unpredictable fluctuations in measurement, such as variations in the environment or inherent limitations of the measurement process.

QUANTIFYING UNCERTAINTY

- Standard Deviation measures the dispersion of a set of values from their mean.
- Confidence intervals provide a range of values within which the true measurement is expected to fall.
- Propagation of Uncertainty propagates the uncertainties associated with each measurement to the final result.

Example: Energy Savings Measurement

- Initial energy consumption measured at 1000 kWh/month, with a standard deviation of 50 kWh.
- Post-Retrofit measurement at 700 kWh/month, with a standard deviation of 30 kWh.

Estimated savings calculated as:

- Initial consumption - Post-Retrofit consumption = 1000 kWh/month - 700 kWh/month = 300 kWh.
- Uncertainty in savings assessed by considering the uncertainties in both measurements.





ROLE OF STATISTICAL SIGNIFICANCE

- In M&V, it is essential to determine whether observed changes in measurements are statistically significant.
- Hypothesis testing can be used to establish significance, such as a null hypothesis (H_0) that states there is no difference in energy consumption before and after the retrofit.

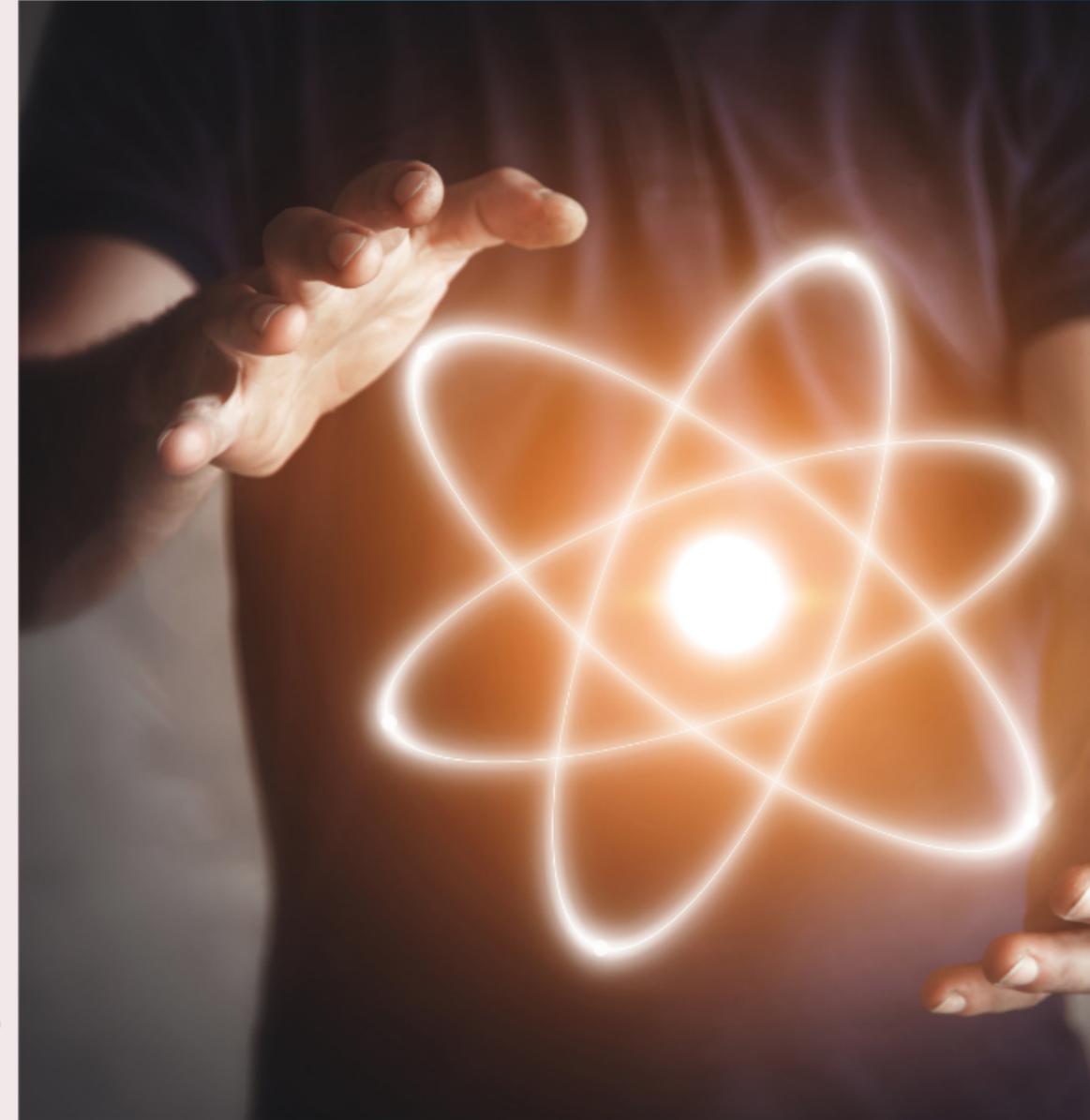


Visualizing Uncertainty

- Graphs and visual representations are powerful tools for communicating uncertainty.
- Error bars on bar graphs illustrate the range of uncertainty associated with each measurement.
- Visual representations can help visualize both the central tendency and dispersion of data.

Contract Structure and Role of M&V

- Performance contracts can be guaranteed savings or shared savings.
- Guaranteed savings model guarantees a certain amount of energy "savings" and is responsible for any shortfall.
- Shared savings model involves the customer and ESCO sharing the risks and benefits of the energy efficiency project.
- The choice between guaranteed and shared savings depends on project scope, financial risk level, and ESCO's capabilities and preferences.



M&V IN GUARANTEED SAVINGS CONTRACT

- The guarantee is set below the expected "savings" to acknowledge uncertainty and reflect potential risks.
- The project is a success if the results are "reasonable" - higher than the guaranteed amount.
- In a shared savings contract, savings for each period are split between the owner and the contractor, requiring a robust M&V plan and good communication.

Standard Weights and Measures

- Standardized methods and algorithms can be beneficial for M&V in certain situations.
- They offer transparency, cost-effectiveness, and transferability.
- They are often developed and maintained by industry associations or government agencies and are freely available to the public.



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