Measurement & Verification (M&V) Framework:

The University of Texas at Austin (UT Austin)

Revolving Fund Energy Conservation Measures (ECMs)

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Acknowledgements

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**Contributors**

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Jim Shrull, Utilities & Energy Management

Bill Mayfield, Utilities & Energy Management

Dennis Nolan, Environmental & Health Safety
Section 1 - Overview & Scope of M&V Framework

This Measurement & Verification (M&V) framework provides a standard for M&V planning and reporting of Energy and Water Conservation measures (ECMs) implemented in University of Texas at Austin (UT Austin) buildings. M&V refers to the process of comparing measured performance data against an adjusted baseline to confirm that calculated annual ECM utility savings actually materialized after implementation.

This M&V framework references specific concepts and practices originating in the International Performance Measurement and Verification Protocol (IPMVP). IPMVP is a widely used protocol developed by a coalition of international organizations (led by the United States Department of Energy) which is applicable across many regions and sectors. The IPMVP serves as the framework for M&V procedures, provides four M&V options, and addresses issues related to the use of M&V in third-party-financed and utility projects. The protocols contained therein are written and periodically updated by the Efficiency Valuation Organization. (EVO)

According to EVO, “M&V is the process of using measurement to reliably determine actual savings created within an individual facility by an energy management program. Savings cannot be directly measured, since they represent the absence of energy use. Instead, savings are determined by comparing measured use before and after implementation of a project, making appropriate adjustments for changes in conditions.”

This framework focuses on key M&V topics and standardizes those unique to UT Austin operations. For any topics not included or expanded upon in this document, users should reference the IPMVP Concepts and Options for Determining Energy and Water Savings Volume 1, January 2012 and IPMVP Core Concepts June 2014.

The topics listed below are to be addressed during verification of savings for ECMs implemented via the Revolving Fund. Details on the below listed topics are included in later sections:

- Defining the Baseline Period & Energy Data
- Documenting Routine & Non-Routine Adjustments
- Determining Utility Rates
- Selecting an ECM-Specific M&V Option
- Evaluating M&V Cost
- Developing M&V Plan
- Publishing M&V Report
Section 2 - Purpose of the M&V Framework

While engineering analysis and calculations will determine expected energy savings in buildings, a thorough M&V process is essential to verify those savings distinctly for individual or a group of ECMS and direct them into future investments – thus creating a measurable return on investment.

Thus there is an important need to “measure and verify” savings generated by an ECM for the following purposes:

- **Improve ECM design and costing:** The development of M&V plans at an early stage will result in comprehensive ECM design and costing.

- **Document financial transactions:** The energy savings generated by ECMS will be used to replenish and grow the revolving fund for future savings in a transparent manner.

- **Enhance credibility and performance of revolving fund:** Effective M&V can provide insight into the best opportunities for investment by sponsors and lead to improved financial performance of the revolving fund.

- **Adhere to IPMVP:** IPMVP presents common principles and terms that are widely accepted as basic to any good M&V process. An ECM complying with IPMVP and conducting M&V activities at key points will help identify issues such as improper ECM installation, lack of proper ECM commissioning, etc. to ensure the gap between calculated and achieved savings is minimal.
Section 3 - Baseline Period

The following conditions should be considered in selecting the baseline period:

- Baseline period should coincide with the period(s) before ECM installation, periods further back in time may not provide a proper baseline for measuring the effect of just the ECM.
- Baseline period should span 12 consecutive months to avoid overstating any seasonal variations.
- If data is missing for a particular month, comparable data for the same month from previous years should be used to ensure baseline period data is complete.
- Reviewing multiple years of data is preferred for baseline period selection, doing so will help iron out any anomalies in energy consumption that may have occurred during baseline periods.
Section 4 - Baseline Energy Data

The following process flow chart should be adhered to in selecting baseline year energy data:

Figure 1: Baseline Year Energy Data
Section 5 - Adjustments

According to EVO, “M&V is the process of using measurement to reliably determine actual savings created within an individual facility by an energy management program. Savings cannot be directly measured, since they represent the absence of energy use. Instead, savings are determined by comparing measured use before and after implementation of a project, making appropriate adjustments for changes in conditions.”

Two types of adjustments are possible:

**Routine adjustments:** Since weather conditions are expected to change routinely during the reporting period, regression techniques are to be used to define the routine adjustment methodology. The recommendation of this framework is that regression technique used should establish the dependence of energy usage on weather conditions by modeling the baseline period (the period prior to the retrofit that is illustrative of pre-retrofit usage). Then, post-retrofit weather should be applied to the baseline model in order to compute the normalized energy data. Routine adjustments will be applicable only for chilled water and steam energy data.

Valid regression techniques must be used to derive the normalized energy data, and should be confirmed using statistical measures such as R-squared and/or CVRMSE.

**Non-Routine Adjustments:** Often there are building conditions that change during the M&V period outside of weather that are considered non-routine. These non-routine changes may impact ECM utility savings and should be documented and adjusted.

Tracking and documentation of the following non-routine changes is defined by the communication plan summarized later in this section and **Appendix B:**

- Square Footage and Space allocation changes
- Standard operating hours
- Building projects and equipment
- Laboratory & Kitchen equipment
- Billing adjustments
- Building and Equipment Outages

Because each of the areas of non-routine changes are managed by different departments within the University, communication will need to be individually tailored according to the type and location of the ECM.

The scope of the communication plan is to track and document the non-routine changes, and not to include techniques to define the adjustment methodology. The cost and resource effort for making non-routine adjustments will be unique to each ECM, and should be based on the magnitude of ECM savings and M&V budget. All non-routine adjustments (N-RA) will be tracked and documented in a N-RA
spreadsheet developed by the ECM project team. Note that during the development of this M&V framework, the N-RA spreadsheet is a concept and not a fully developed spreadsheet. For specific information to be documented for each non-routine adjustment, refer to Appendix B.

**Square Footage and Space allocation changes**

Information requested: Large variations in square footage in a building during the baseline and reporting period.

Based on the scope of the ECM, the % variation of square footage may warrant additional investigation and this will be determined by the engineer. In addition, any large space use changes that have occurred in the building during the baseline and reporting period - for e.g., office space that is changed into a laboratory, will need to be tracked. For UT Austin, state legislature requires that space data is updated within 30 days of substantial completion.

Primary contact: Sue Stewart, Sue.Stewart@austin.utexas.edu and Jenny Nedroscik, jenny.knauer@austin.utexas.edu

Information Access: Space Tableau

**Standard Operating Hours**

Information requested: Standard open and closed hours of the buildings for public use and operations.

Standard open and closed hours are determined by the building managers and are catalogued by Custodial Services. These hours of operations only change per the request of the building manager. There is a one day delay in updating the information for building hours on the SharePoint site that Custodial Services manages.

Primary contact: Sally Moore, Sally.Moore@austin.utexas.edu and Denise Schmidt, denise.schmidt@austin.utexas.edu

Information Access: Tableau Visualization

**Building Projects and Equipment**

Information requested: PMCS and OFPC projects occurring in a building at the same time as an ECM implementation.

If the PMCS or OFPC project scope of work (SOW) includes mechanical, electrical and/or plumbing (MEP) work, further investigation may be warranted. Additional requested documentation include: as-built, specifications of equipment, and load calculations. Equipment changes resulting from PMCS and OFPC projects are tracked by Engineering and Technical Support through EQ IDs and Add/Delete logs. The equipment changes should be monitored throughout an ECM lifecycle. Currently, there is a time delay in EQ IDs updates of approximately 5-6 months. If information regarding equipment in the building cannot be found, field verification may be necessary.
Primary contacts: Randy Hooper, randy.hooper@austin.utexas.edu, Michael Walker, michael.walker@austin.utexas.edu and Aziz Hussaini: aziz.hussaini@austin.utexas.edu

Information Access: Tableau, Meridian

**Laboratory & Kitchen Equipment**

Information requested: High-energy consumption laboratory and kitchen equipment that is moved in and out of the building.

Depending on the scope of the ECM and the M&V option chosen (A, B, C, D) laboratory and kitchen equipment inventory may need to occur throughout the M&V period. Lab and kitchen equipment that have a large energy and water impact are:

- Fume hoods
- Autoclaves
- Lasers (depending on size and frequency of use)
- Ultra-low freezers
- Bio safety cabinets (ducted cabinets only)
- Ovens (depending on size)

_Labs 21 Wiki_ can also serve as a resource for efficiency levels of lab equipment.

Primary contact: Building/Kitchen Manager and/or Dennis Nolan, dnolan@austin.utexas.edu

Information Access: Refer to **Appendix B**

**Billing Adjustments**

Information requested: Billing adjustments and meter errors/shutdowns during the reporting period.

Primary contacts: Bill Mayfield, Bill.mayfield@austin.utexas.edu and Jim Shrull, Jim.shrull@austin.utexas.edu

Tools and Access: Refer to **Appendix B**

**Building and Equipment Outages**

Information requested: Building and equipment outages should also be tracked to determine if they impact the M&V analysis.

Primary contacts: Debbie Carrington, Debbie.carrington@austin.utexas.edu

Tools and Access: Outage Calendar (Facilities Monitoring Log)


Section 6 - Utility Rates

The following steps should be followed in determining natural gas rates, and assigning cost values to energy savings:

- Obtain and review current natural gas rates from the UEM gas chart data. Care should be taken to ensure that data for the same baseline period is reviewed.
- An average of the 12 month period rates should be used to determine baseline period rate.
- An escalation factor, if necessary for reporting period utility rate should be determined in consultation with the UEM Billing Department.
- After approval of the agreed upon utility rate by the UEM Billing Department, the rate will be used to calculate and document cost savings for each annual reporting period of the ECM.
Section 7 - M&V Options

M&V is a process that follows the below listed fundamental principles:

**ACCURATE:** M&V reports should be as accurate as the M&V budget will allow. M&V costs should be less than 10% of the monetary value of the savings being evaluated. M&V expenditures should also be consistent with the financial implications of over- or under-reporting an ECM’s performance. Accuracy tradeoffs should be accompanied by increased conservativeness in any estimates and judgements.

**COMPLETE:** The reporting of energy savings should consider all effects of an ECM. M&V activities should use measurements to quantify all the significant measurable parameters, while estimating all others.

**CONSERVATIVE:** Where judgements are made about uncertain savings quantities, M&V procedures should be designed to under-estimate savings.

**CONSISTENT:** The reporting of an ECM’s energy effectiveness should be consistent among:

- Different types of ECMs
- Different energy management professionals for any one ECM
- Different periods of time for the same ECM

**RELEVANT:** The determination of savings should measure the performance parameters of concern, or least well known, while other less critical or predictable parameters may be estimated.

**TRANSPARENT:** All M&V activities should be clearly and fully disclosed. Full disclosure should include presentation (in the M&V plan and M&V report) of all of the elements defined in chapters 5 and 6 of the IPMVP Core Concepts June 2014

Based on these principles the IPMVP provides four different acceptable approaches (called Options) for measuring and verifying savings. All four options use the following fundamental formula:

\[
\text{Savings} = (\text{Baseline Energy} - \text{Reporting Period Energy}) \pm \text{Routine Adjustments} \pm \text{Non-Routine Adjustments}
\]
The four options for determining savings – A, B, C, and D – are described in detail in IPMVP Core Concepts June 2014.

*Table 1: Overview of IPMVP Options*

<table>
<thead>
<tr>
<th>IPMVP OPTION</th>
<th>SAVINGS CALCULATIONS</th>
<th>TYPICAL UT AUSTIN APPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option A: Key Parameter</td>
<td>Engineering calculation of baseline and reporting period energy from short-term</td>
<td>Lighting Retrofit</td>
</tr>
<tr>
<td>Measurement</td>
<td>measurements of key parameter and estimated values for non-key parameters.</td>
<td>Steam System Repairs</td>
</tr>
<tr>
<td></td>
<td>Routine and non-routine adjustments as required.</td>
<td>Valve Replacement</td>
</tr>
<tr>
<td>Data collection and sample</td>
<td></td>
<td></td>
</tr>
<tr>
<td>size requirements for key</td>
<td></td>
<td></td>
</tr>
<tr>
<td>parameter measurements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>should be referenced from</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IPMVP Vol 1 Jan 2012.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimates for non-key</td>
<td></td>
<td></td>
</tr>
<tr>
<td>parameters can be based on</td>
<td></td>
<td></td>
</tr>
<tr>
<td>historical data, manufacturer's</td>
<td></td>
<td></td>
</tr>
<tr>
<td>specifications, or engineering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>judgement.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Option B: All Parameter</td>
<td>Engineering calculation of baseline and reporting period energy from short-term or</td>
<td>Variable Frequency Drives</td>
</tr>
<tr>
<td>Measurement</td>
<td>continuous measurements of all parameters.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Routine and non-routine adjustments as required.</td>
<td></td>
</tr>
<tr>
<td>Data collection and sample</td>
<td></td>
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<tr>
<td>size requirements for key</td>
<td></td>
<td></td>
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<tr>
<td>parameter measurements</td>
<td></td>
<td></td>
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<tr>
<td>should be referenced from</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IPMVP Vol 1 Jan 2012.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Option C: Building Energy Use</td>
<td>Analysis of whole facility baseline and reporting period meter data.</td>
<td>Re-Commissioning and Control Strategies affecting large portion of</td>
</tr>
<tr>
<td></td>
<td>Routine and non-routine adjustments as required.</td>
<td>Chilled Water and Steam Consumption.</td>
</tr>
<tr>
<td>Option D: Calibrated</td>
<td>Energy use simulation, calibrated with hourly or monthly billing data.</td>
<td>ECM affecting large portion of the energy consumption, and</td>
</tr>
<tr>
<td>Simulation</td>
<td></td>
<td>where no meters existed in the baseline period. Application of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>this option will be rare since meter data is available for over</td>
</tr>
<tr>
<td></td>
<td></td>
<td>90% of the space on campus.</td>
</tr>
</tbody>
</table>
The choice among the M&V options involves many considerations, one of which is the definition of the measurement boundary (e.g., an individual ECM or an entire building).

The following Decision Tree based on calculated ECM savings should be adhered to in choosing the ECM-specific M&V option.

![IPMVP Decision Tree](image)

Figure 2: IPMVP Decision Tree
Section 8 - M&V Costs

Annual M&V costs will typically vary depending upon the IPMVP options utilized. Given the wide variability among ECM technologies, it is difficult to provide option-by-option cost estimates. IPMVP guides that M&V costs are typically less than 10% of the total ECM savings.

Factors which influence the appropriate level of M&V and thus the cost of M&V include:

- Value of projected savings
- Complexity of the ECM versus efficiency of the equipment
- Total number of equipment
- Number of interactive effects among resource consuming systems
- Level of uncertainty of savings
- Availability and capability of building meter data

UT Austin internal engineering & reporting will not be a burden to the M&V costs. However, the following labor & material costs should be estimated for the considered M&V option:

- Technician and equipment cost for pre and post-measurements
- Technician and equipment cost for installing new meters
- Technician and/or product cost for building simulation
- Third-party review of the M&V plan and/or M&V report

<table>
<thead>
<tr>
<th>IPMVP Option</th>
<th>Measurements</th>
<th>Meters</th>
<th>Simulation</th>
<th>Third-Party Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option A</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Option B</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Option C</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Option D</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Table 2: M&V Costs Matrix

The following M&V cost estimate ranges should be followed when choosing the M&V option.

Option A = 3-7% of total ECM savings
Option B = 5-10% of total ECM savings
Option C = 1-5% of total ECM savings (if meters are already installed)
Option D = 5-10% of total ECM savings
Section 9 - M&V Plan

A key component of an IPMVP adherent project is the documentation of a well-developed and customized M&V plan. This section describes the minimum requirements of an M&V plan.

Overview of M&V Plan: Provide a short summary of the plan including:

- ECM intent
- M&V option to be used
- M&V activities to be conducted during the baseline and reporting period.

Baseline period: The baseline period documentation should include:

- Baseline period energy consumption and demand data
- Baseline period measurements, if any
- Baseline period estimates and assumptions including the basis for the data
- Routine Adjustments that may be required
- Non-Routine Adjustments that may be required, including data documented during the baseline period

Reporting period: The reporting period should include

- Expected reporting period timeline
- Planned M&V activities
- Parameters that will be measured and/or estimated including the basis for the data

Savings Calculation Methodology: Specify the methods used to calculate savings including but not limited to the following – utility billing data including adjustments, engineering spreadsheets, straight calculation, BIN analysis, regression, computer modeling, and other computation techniques.

Calculated Savings: List the calculated annual and/or cumulative MMBTUs of natural gas savings for applicable utilities.

Utility Rates: Document the natural gas rate used in savings calculations, and how savings will be calculated if natural gas rate changes during the reporting period.

Monitoring and Reporting Responsibilities: Assign responsibilities for measurement & verification during the reporting period

- Review of reporting period consumption and demand data
- Tracking and documenting routine and non-routine adjustments
• Publishing and Review of M&V Report

M&V Costs: Document both, the initial development costs and annual costs throughout the reporting period.
Section 10 - M&V Report

M&V reports are typically prepared as defined by the M&V plan. The following section describes the minimum requirements of an M&V report.

Overview of M&V Plan: Provide a short summary of the plan including ECM intent, M&V option used and M&V activities conducted during the baseline and reporting period.

Observed Data of Reporting Period:
- Energy consumption and demand data
- Measurement period start and end point in date/time
- Routine and Non-Routine changes
- For Option A and B, the measured and estimated parameters
- Description and justification for any corrections made to the observed data

Adjustment Methodology: Document the methods used for calculating the routine and non-routine adjustments.

Utility Rates: The agreed upon natural gas rate from the M&V plan OR the reporting period natural gas rate, whichever is higher will be used to calculate the cost savings.

Achieved Savings: List the achieved annual and/or cumulative MMBTUs of natural gas savings for applicable utilities.

Non-Energy Benefits: Provide an overview of non-energy benefits (occupant comfort, maintenance reduction, etc.) observed during the reporting period of the ECM.
Appendix A: Terms and Definitions

**Adjusted baseline energy:** The energy use of the baseline period, adjusted to a reporting period's conditions.

**Baseline Energy:** The energy use occurring during the baseline period without adjustments.

**Baseline Period:** The period of time chosen to represent operation of the building before implementation of an ECM.

**Consumption:** the total amount of energy used in a building.

**CVRSME:** A statistical measure that describes how much variation or randomness there is between the data and the model.

**Demand:** the rate of energy consumption in a building.

**Energy Conservation Measure:** An activity or set of activities designed to increase the energy and/or water efficiency of a building, system or piece of equipment.

**Non-Routine Adjustments:** The adjustment to energy use affected by an isolated event. Example: change in building operating hours or installation of new ventilation system.

**Pre-Retrofit:** The period of time before outfitting a building or system with new parts or equipment.

**Post-Retrofit:** The period of time after outfitting a building or system with new parts or equipment.

**Routine Adjustments:** The adjustments to energy use affected by variables that are expected to change routinely. Example: Ambient temperature.

**Regression:** A statistical technique that estimates the dependence of a variable (such as energy consumption) on one or more independent variables, such as temperature.

**R-Squared:** A statistical measure of how well future outcomes are likely to be predicted by the model.

**Reporting Period:** The period of time following implementation of an ECM when savings reports adhere to IPMVP.

**Space Allocation:** Classification and use of building space on campus by education and general departments, operational units, external vendors and all other entities.
Appendix B: Documenting Non-Routine Adjustments

Square Footage changes

1. For the baseline period of an ECM check the Space Tableau and select the “BuildDiffOver 7%” tab. Then choose the baseline date to compare the current date and record the baseline square footage. Note: Functional Area is the assigned area of a space in the building, not the gross square footage.

2. Track this number in the Non-routine adjustment (N-RA) spreadsheet.

3. For the M&V reporting period, repeat step #1 and record the baseline and current square footage and the % difference.

4. If this square footage number varies by +/- 7% and is larger than 100,000 square feet, investigate which floor the changes occurred in by going to the “ComparisonSelector” tab. This will outline any difference per floor. Record this number in the N-RA spreadsheet.

   To determine if you will need to do a site investigation or not, check the “Room TypeComparison” tab and the associated floors where differences were recorded in step 4.

5. Record changes in the N-RA spreadsheet.

Space allocation changes

1. For the baseline period of an ECM, check the Space Tableau and select the “Room TypeComparison” tab. This will display the rooms, allocation space categories, Month, day, year of Effective Form, Effective to date. Any variations of space changes are marked by an X.

2. Record any space changes. The majority will not require investigation, but if a laboratory is changed to an office a field visit might be required.

3. For the reporting period of the ECM, follow steps 1 -2 and cross verify if any spaces changes have occurred.

4. If it is determined that space usage changes will effect M&V, field verify that the changes were accurate.

Standard Operating Hour Changes

1. For the baseline period of an ECM, check the Building Hours Tableau to record open and closed hours of operations. This Tableau will show the open/closed hours for all UT buildings on campus. Notes and Notes2 will track changes to the building. If notes indicate change of hours during baseline period contact Sally Moore and/or Denise Schmidt for changes and date implemented.

2. Record standard operating hours on the N-RA spreadsheet.
3. Once the ECM is implemented check the Building Hours Tableau and record the open and closed hours in the N-RA spreadsheet.

4. At the end of the M&V period check the Building Hours Tableau and record the open and closed hours and record any changes in the N-RA spreadsheet.

5. If there are any questions regarding building hours, contact Sally Moore or Denise Schmidt

**Building Projects and Equipment**

1. For the baseline period of an ECM, check the UTM OFPC & PMCS Projects Tableau Viz. This Tableau Visualization will allow you to record if there are projects (planned, open, or being constructed) in the building where an ECM is implemented. There are two tabs in the Visualization to review: Planned Construction (design and construction phase) and Projects in Open Status (these are either in open status due to funding or continuous work).

2. If the ECM impacts the same equipment, email project PM and communicate the scope of the ECM being implemented. Include the following information:
   a. Title
   b. ECM Project Number (CP)
   c. Current Status
   d. Planned Schedule
   e. Scope
   f. ECM calculated savings

3. Record existing equipment in building as it relates to the ECM using the Equipment Display Tableau Viz. Sort by building, equipment type, and status (on line) and then export data (red circle) by “Crosstabs” which will result in an Excel file.

4. Save downloaded data in the N-RA spreadsheet.

5. After ECM is implemented, review steps 1-5 for most up-to-date schedule of project and changes in equipment. Depending on the schedule of the PMCS or OFPC projects, the ECM project may not be impacted. Note: This might vary if the PMCS and/or OFPC project has been completed but the EQ IDs have not been updated. Record any changes.

6. After ECM M&V reporting period is complete, review steps 1-5 for most up-to-date schedule of project and changes in equipment. Verify with PM that documented changes are correct.

7. For access to as-built, specifications, and necessary documentation you can review the Meridian database. If information is not found in the database, contact PM for additional information.
Note: Often these logs are incomplete and not updated until 6 months after substantial completion. Depending on calculated M&V savings, it may be necessary to field verify equipment in the building.

Laboratory & Kitchen Equipment

1. For the baseline period of an ECM, email the assigned Building/Kitchen Manager and/or Dennis Nolan (EHS) for any inventory they have for the following equipment items in the specified building.
   a. Fume hoods
   b. Autoclaves
   c. Lasers (depending on size and frequency of use)
   d. Ultra-low freezers
   e. Bio safety cabinets (ducted only)
   f. Ovens (depending on size)

   Request also any additions and deletions of laboratory and kitchen equipment the previous year.

   You can find the Building Managers by going to the Facilities Services Building Information webpage and sorting for a specific building.

2. Save this inventory in the N-RA spreadsheet.

3. Provide an add/delete log for Dennis and the Building Manager to record any equipment changes that occur for the scheduled M&V period.

4. At the end of the ECM M&V reporting period, email the assigned Building Manager to request any additions/deletions of laboratory equipment during implementation.

5. Record any changes in the N-RA spreadsheet.

Note: Often these logs are incomplete and vary. Depending on calculated M&V savings, it may be necessary to field verify equipment in the building.

Billing Adjustments

1. Send Billing, Mechanical Distribution & Electrical Distribution staff listed below an ECM status via a database or regular communication email (examples of ECM status: in development/under implementation/in M&V reporting period) on a periodic basis.
   a. Adriana Rojas
   b. Bill Mayfield
   c. Jim Shrull
2. Any Electrical Distribution updates (meter removal/meter replacement/new meter updates) will be sent via email and tracked on the N-RA spreadsheet.

3. Any Mechanical Distribution updates (meter removal/meter replacement/new meter updates) will be communicated during the monthly proof meetings and tracked on the N-RA spreadsheet.

Building and Equipment Outages

To review scheduled outages throughout the M&V period go to the Campus Outage Calendar and track any necessary changes. Note: If you need access to this calendar, contact Tommy Crawford in Building Operations.
## Appendix C: References

<table>
<thead>
<tr>
<th>Document Name and Version</th>
<th>Location</th>
</tr>
</thead>
</table>