



Section: Continual Improvement

Task 14: We have ongoing monitoring and analysis of our energy consumption, SEUs, relevant variables, and action plan progress and effectiveness

Getting It Done

- Use the [Monitoring and Measurement of Key Characteristics Planning Worksheet](#) and/or the [Energy Measurement Plan Worksheet](#) to determine how and how frequently your organization will monitor, measure and analyze the key characteristics that determine your energy performance. Key characteristics include:
 - Energy consumption for all energy sources
 - [Significant Energy Uses \(SEUs\)](#) and [Relevant Variables](#)
 - [Improvement Opportunities](#)
 - [Performance Indicators \(EnPIs\)](#)
 - Action plan progress and effectiveness
 - Actual vs expected energy consumption
- If not already addressed as part of energy planning, assign responsibilities and implement ongoing monitoring, measurement, and analysis of your organization's energy consumption for all energy sources.
- Implement regular monitoring, measurement, and analysis of your facility's key characteristics according to your monitoring, measurement, and analysis plan.

Task Overview

Monitoring, measurement, and analysis of performance metrics is the logical extension of the data analyses conducted in Group 2 (Energy Review). Effective decisions on energy management rely on the ongoing collection and analysis of energy and other data. Calibration systems are used to ensure that accurate data are collected for reliable analyses.

Monitoring, measurement, and analysis enable the organization to determine:

- if significant energy uses are being appropriately managed,
- if the organization is meeting its current energy objectives and targets, and
- if energy performance trends are focused in the desired direction.

To help the organization make these determinations, monitoring, measurement and analysis is applied to the "key characteristics" of the organization's operations that determine energy performance. These key characteristics include energy consumption, the SEUs and their relevant



variables, energy opportunities, EnPIs, effectiveness of action plans and actual vs expected consumption.

Identifying significant energy uses (SEUs) and relevant variables are a part of energy planning (see [Data Analysis](#) and [Relevant Variables](#)). Once determined, you must monitor, measure, and analyze the SEUs and relevant variables to evaluate energy performance and any changes or improvements.

SEUs are an important focus of the EnMS. Monitor the energy performance of your SEU(s), as small changes in their operation or deviations in procedures, equipment, or maintenance can affect your organization's overall energy consumption.

Opportunities for improvement are another output of the energy review. This process must be dynamic to ensure that new opportunities are continually identified, evaluated, and implemented to improve energy performance and the EnMS. Regular action plan monitoring ensures the improvement projects stay on track and the action plans are kept up to date. Action plan progress and results are measured and analyzed to ensure that the objectives and targets are being met effectively. Action plans should also include estimates for energy performance improvement expected from the action plan's implementation. A thorough review of the action plan will include an evaluation of the plan's actual results compared to the estimates.

In the next task ([Measurement](#)), an energy measurement plan will be developed.

At the completion of this task, you will have...

- Monitored and analyzed consumption for all sources of energy
- Monitored and analyzed significant energy uses and relevant variables
- Checked on action plan progress
- Checked action plan effectiveness
- Monitored energy opportunities
- Evaluated actual versus expected energy consumption

This guidance is relevant to Section 4.6.1 of the ISO 50001:2011 standard.

Associated Resources	Short Description
SEU Control Chart	A template spreadsheet form to track, record, and validate the implementation process for SEUs.
SEU Control Chart Example	An example of what an SEU control chart can look like and may be used to track/record/document/validate the PDCA process.
SEU Future Energy Estimate Worksheet	This worksheet provides users with a spreadsheet to calculate expected energy consumption demands.



Associated Resources

Short Description

ENERGY STAR Guidelines for Energy Management	ENERGY STAR Guidelines for Energy Management guidance document.
Energy Footprint Lite Data Uploader	The Energy Footprint Lite Data Uploader provides a structure format to track energy consumption and relevant variables.

Full Description

Monitoring, measurement and analysis is applied to the key characteristics of the organization’s operations that determine energy performance. Key characteristics include:

- Past and present energy consumption
- The SEUs and their relevant variables
- Energy performance improvement opportunities
- EnPIs
- Effectiveness of action plans in achieving the energy objectives and targets, and
- Actual vs expected energy consumption

Monitor and analyze consumption for all sources of energy

Energy sources were identified, and past and present energy consumption data (including building, equipment, system, or process levels) were initially collected and analyzed, as part of the energy review (see [Data Collection](#) and [Data Analysis](#)). This information was used to accomplish the following:

- Profile your organization’s energy use and energy consumption
- Determine your organization’s significant energy uses
- Identify and prioritize energy performance improvement opportunities
- Develop energy performance indicators and baselines needed to evaluate energy performance

Energy consumption needs to be continually monitored, as it is a key component of energy performance evaluation and using less energy is the goal of energy performance improvement. Present energy consumption is compared against past consumption using trend lines, spreadsheets, statistical techniques, and other approaches. Various methods of data analysis were discussed in [Data Analysis](#).

Energy consumption data should be:

- monitored and measured prior to any change being made (baseline),
- monitored and measured after the change is implemented and compared with the baseline (or pre-implementation measurement),
- representative of normal operating conditions, and



- reflective of consistency in factors that can affect energy performance such as weather, occupancy, production, or hours of operation.

Learn More: **Monitoring and analyzing consumption for all sources of energy**

Example sources of data – Metering energy consumption from the source generally involves utility meters for electricity and natural gas located on your organization’s property. These data are convenient and readily available in the utility bills, but the meters can also be read and recorded regularly by the organization as part of a regular monitoring program. Measurement methods may vary for other energy sources. Wood or coal may require scales either on-site or measured by the contractor. Propane and fuel oil may be metered from a delivery truck or provided by tank. Renewables will require metering appropriate to the form of delivery.

Consider monitoring and measurement at finer levels – Metering also can be at the building, equipment, system, or process level using submeters, installed equipment meters, or portable meters. Monitoring and measuring energy consumption at finer levels (e.g., at the level of equipment, systems, or processes) allows for more detailed analyses and better evaluation of energy performance. Data monitoring at finer levels could more easily reveal deviations from expected energy performance and give an early warning of potential problems developing in the equipment, systems, or processes that are consuming energy. For example, an increase in electricity consumption could indicate lights are being left on or equipment is starting to fail.

Evaluate data under consistent conditions – Consumption must be evaluated under consistent conditions for it to be a reliable indicator of an improvement or decline in energy performance. Data should be collected prior to any changes being made to serve as a baseline for comparison with data collected after changes are made (e.g., pre- and post-measurements for action plans, process changes, and the like). The data collected before and after the changes are implemented should be representative of normal operating conditions.

Data should also reflect as much consistency as possible in other factors that could affect energy performance such as weather, occupancy, production, or hours of operation. For example:

The benefit of installing more efficient lighting might be masked or even eliminated if the electricity consumed by new lighting in the wintertime was compared to the electricity consumed by old, less efficient lighting during the summer, when there is more daylight and potentially less lighting use.

To perform accurate evaluations, it is important to understand potential variations and their effect on energy consumption so energy performance can be accurately evaluated. If consistency in factors and conditions can be established, consumption may be a viable indicator of energy performance. If not, consumption may still be a key factor in determining performance as part of the data required for an energy performance indicator (see [Performance Indicators \(EnPIs\)](#)).

Monitor and analyze significant energy uses and relevant variables



Monitor and measure the energy performance of the SEUs, and compare it with past history to:

- Maintain or restore effective operation
- Control energy use and consumption
- Evaluate the opportunity for improvements
- Determine the effectiveness of improvements
- Evaluate the appropriateness of maintaining the equipment, system, process, or facility as an SEU

Monitoring the energy performance of a SEU can involve measuring energy consumption, related operational and maintenance parameters, relevant variables associated with the SEU, or some combination of these. (Monitoring of EnPIs is discussed in [Performance Indicators \(EnPIs\)](#)).

Learn More: **Monitoring the energy performance of a SEU**

Energy consumption – Direct energy consumption comparison is one of the easiest methods of evaluating energy performance, but it presumes consistent operating conditions. ([Monitoring](#) discusses energy consumption measurement.) It also presumes that appropriate energy measurement equipment is in place. For some applications, direct consumption measurement may be expensive or inconvenient. However, if operating conditions are consistent and metering is available, direct consumption comparison is generally the most convenient form of energy performance evaluation.

Operational and maintenance parameters – Energy consumption and EnPIs are not the only method for determining energy performance. Measurement and analysis of operational and maintenance parameters can also be used. Operational and maintenance parameters could include:

- Temperature
- Pressure
- Flow
- Occupancy levels
- Run time
- Demand

For example:

A decrease in run time of an air conditioning system (under consistent inside and outside environmental conditions) can be an indicator of improved energy performance as a result of filter changes and coil cleaning. For a boiler, the efficiency can be determined by measuring the



temperature and oxygen level of a sample of the stack gas using a stack gas analyzer. Regular monitoring of efficiency is a typical maintenance activity that can provide an indication of energy performance.

Relevant variables – Relevant variables associated with your organization’s SEUs were identified in [Data Analysis](#) and [Significant Energy Uses \(SEUs\)](#). These could include:

- Weather
- Occupancy
- Operating hours
- Line speeds
- Moisture levels
- Firing rate

Relevant variables must be regularly monitored, measured, and analyzed to evaluate their impact on energy performance of the SEU. Use these data in conjunction with facility, equipment, system, or process data to ensure consistent evaluation of energy performance. As an example:

Air conditioning electricity consumption will vary depending on the weather conditions. By collecting temperature and humidity data, improvements to the system can be evaluated under consistent conditions before and after the improvement is implemented, or the data can be normalized for weather. Occupancy also can affect energy consumption due to a change in lighting or heating and cooling requirements. Use time cards, vacation schedules, sign in sheets, etc. to collect data to evaluate energy performance either under consistent conditions or by normalizing the data for occupancy.

Collect data for each of the relevant variables using the appropriate collection mechanism. For example, collect temperature and humidity data for weather using manual or recording thermometer and humidistat. Another example is to collect attendance information for occupancy using sign in sheets, time clock records, etc.

Making SEU Connections – The [SEU Control Chart](#) introduced in [Relevant Variables](#) and [Data Analysis](#) is intended to be a concise roadmap to your organization’s management of its SEUs. It can point the user to the required connections between each SEU and its associated:

- operational controls,
- competency and training requirements,
- **monitoring and measurement (column 6),**
- calibration, and
- records.

Completing SEU Control Chart columns 1 through 5 was discussed as part of implementing [Relevant Variables](#)



and [Data Analysis](#). As part of this task, you can complete column 6 to provide references to (or descriptions of) the monitoring and measurement implemented to track and analyze each SEU's performance. Also, you can add to column 8 by listing the monitoring and measurement records that will be maintained related to the SEUs. (See the completed [SEU Control Chart Example](#)). You can complete column 7 as part of [Measurement](#).

Check on action plan progress

Regular monitoring of the action plans ensures that the improvement projects stay on track and the action plans are kept up to date.

The management representative and/or the energy team should review the following items at planned intervals (e.g., weekly, monthly, quarterly):

- Milestone and task completion dates
- Resource allocations
- Personnel assignments
- Status reporting
- Ongoing monitoring and measurement of the objectives and targets
- Team communication

Team communication should be reviewed to ensure that any changes to the action plans are communicated to the appropriate personnel and potential impacts from delays in meeting milestone and task completion dates are known. This review is especially helpful where milestones or tasks are contingent on the progress of other milestones and tasks.

Check on action plan effectiveness

As we discussed in [Improvement Projects](#) energy management action plans are developed to define the actions that will be used to achieve the energy objectives and targets associated with energy opportunities to be implemented (i.e., projects). Action plans are monitored, measured, and analyzed to ensure that the objectives and targets are being met effectively.

The expected energy consumption associated with a project that is implemented is compared to the actual results after the project is completed. This comparison tells you whether the energy savings you anticipated were actually achieved. The methods used to perform this verification were defined in the action plan (see [Improvement Projects](#)).



Successful projects are analyzed for appropriate reproduction in other processes. Projects where targets are not met are analyzed to determine the reason(s) for the shortfall, and appropriate follow-up is planned and implemented. The action plan can be analyzed during and/or after completion. Action plans that are not generating the intended results are modified as needed.

Learn More: **Indicators that action plans are not effective**

- Energy objectives not being met
- Energy targets not being met
- Unable to meet due dates
- Personnel not available
- Budget not sufficient/available
- Inadequate technology
- Change in priorities

As action plans are completed, the resulting improvements are incorporated into the management system evaluation of energy performance to ensure that the energy savings resulting from the action plan are maintained over time.

Monitor energy opportunities

Opportunities for improvement are another output of the energy review. You identified, evaluated, and prioritized opportunities in [Improvement Opportunities](#). Your organization either pursues appropriate opportunities further with development of energy objectives, targets, and action plans or removes them from the active list. Additional monitoring or measurement may be required to verify the suitability of installation procedures, operating criteria, control, and maintenance practices or to evaluate the energy performance improvement. These items are typically defined and addressed in the action plan (see [Improvement Projects](#)).

Also, you need to monitor the process for identifying and prioritizing the improvement opportunities to ensure the process remains effective, the list is kept up to date, and opportunities are effectively addressed to improve energy performance. This process must be dynamic to ensure new opportunities are continually identified, evaluated, and implemented to improve energy performance and the EnMS.

Learn More: **Examples of monitoring activities for energy opportunities**

- frequency of new opportunity identification,
- frequency of opportunity completion,



- removal from the list when no longer appropriate, and
- evaluation of continued relevancy of the prioritization criteria.

Evaluate actual versus expected energy consumption

Implementing energy opportunities is accomplished through energy management action plans. Action plans should include estimates for energy performance improvement expected from the action plan's implementation. Analyze variances between the action plan's actual versus expected results and evaluate that information to identify elements that improve performance or identify problems to address. The results of this analysis should be recorded as feedback for the corrective action process, to improve future action plan implementation and energy performance improvements.

Future energy use and consumption was estimated for the SEUs as part of the energy review (see [Significant Energy Uses \(SEUs\)](#)). Your organization decides for itself what period of time is considered to be "future" and monitors the assumptions (or criteria) that you used to estimate future energy use of the SEUs. You may have already started or completed the [SEU Future Energy Estimate Worksheet](#) in [Significant Energy Uses \(SEUs\)](#). If so, then make sure you have a process to review and update those estimates as needed on a regular basis and in response to major changes to facilities, equipment, systems, and processes.

Learn More: Using DOE EnPI Lite

If using [EnPI Lite](#), it is recommended that you keep your [Energy Footprint Lite Data Uploader](#) file current. This will facilitate the development of new facility-level energy models in [EnPI Lite](#) and continually track your facility-level energy performance improvement and energy consumption.