Section: Planning

Task 11: We identify energy performance indicators and energy baselines to measure and monitor our energy performance and to demonstrate energy performance improvement. We have a methodology for determining and updating them.

Getting It Done

1. Develop one or more energy performance indicators (EnPIs) for your organization at the EnMS scope-level, as well as, for each significant energy use (SEU). If relevant variables significantly affect energy consumption, normalize the EnPIs.
2. Develop an energy baseline (EnB) for each EnPI in order to later determine energy performance improvement.
3. Communicate proposed EnPIs and EnBs to top management so they can ensure the EnPIs and EnBs are appropriate for the organization.
4. Record and regularly review the method used to determine and update EnPIs, and establish the conditions under which adjustments to the baseline(s) will be made.
5. Compare EnPI values to their respective EnBs on a regular basis.
6. Implement a process for ongoing monitoring, measurement, and analysis of your EnPIs, EnBs, and energy performance improvements.
7. If you are planning on seeking SEEC 50001 Ready recognition for this project please refer to the "Get Ready Recognized," webpage of the SEEC 50001 Ready Navigator to ensure you select an EnPI, EnB, and method for demonstrating energy performance improvement allowed by the recognition program. To achieve Ready recognition, energy performance improvement is demonstrated for the same scope and boundaries as your SEEC 50001 Ready EnMS.

Task Overview

Energy performance indicators (EnPIs) are quantitative metrics used to monitor energy performance and demonstrate energy performance improvement. As quantitative measures, energy performance indicators are measured values, ratios, or models your organization accepts as meaningful representations of energy performance. Where the EnPI is the metric by which to measure energy performance, the EnPI value is the measured or calculated number for a specific time period of measure (e.g., kilowatt-hours [kWh] is the EnPI and 42 is the EnPI value; together they indicate an energy performance of 42 kWh).

An energy baseline (EnB) is the quantitative reference used for comparing current EnPI values to determine if energy performance has improved. Typically, energy baselines are associated with EnPIs and represent the value of an EnPI during a time interval known as the *baseline period.* Often a baseline is established by an organization's strategic initiatives or in response to a legal or other

requirement. The baseline is established considering the data period(s) suitable for your organization's energy use and consumption.

EnPIs and EnBs can be established at the level of the entire organization or at the level of a specific sites, piece of equipment, system, or process. ISO 50001 requires, but does not specify for what scope and boundaries, that an organization must demonstrate energy performance improvement. As they are the focus of energy performance improvement actions, it is recommended that each SEU have at least one EnPI and associated EnB. If you are planning on seeking SEEC 50001 Ready recognition for this project please refer to the "Get Ready Recognized," page of the SEEC 50001 Ready Navigator to ensure you select an EnPI, EnB, and method for demonstrating energy performance improvement allowed by the recognition program. To achieve Ready recognition energy performance improvement is demonstrated for the same scope and boundaries as your SEEC 50001 Ready EnMS.

As discussed in Task 8 Energy Data Collection and Analysis relevant variables are quantifiable factors that routinely change and have a major impact on energy performance, including the operational performance. EnPIs and EnBs that take relevant variables into account may be more meaningful than those that depend on the intended use of the EnPI and EnB. Where the organization has data indicating that relevant variables significantly affect energy performance, the EnPIs should consider the relevant variables into account. The organization determines what indicates that a variable "significantly affects energy performance" and should develop a criteria to follow. If relevant variables are identified, the EnPI should be normalized, meaning absolute energy consumption itself cannot be used as the EnPI. Instead, the EnPI needs to be adjusted through the use of an energy intensity, regression, or other adjustment method.

Responsibility for determining EnPIs and EnBs typically rests with the energy team. It is top management's responsibility to ensure that the EnPIs and EnBs are appropriate for your organization and to provide the resources needed to establish, track, and evaluate the EnPI values.

Once the EnPIs and EnBs are established, it is vital to analyze and monitor them and their associated EnPI values. The benefit of analyzing EnPIs values is that by making the comparison to the EnBs, it shows the direction and rate of change in organizational energy performance. Since the ultimate objective of energy management is continual improvement, consistent trends in actual and predicted energy performance can demonstrate and quantify the improvement.

This guidance is relevant to sections 6.4 and 6.5 of the ISO 50001:2018 standard.

Associated Resources	Short Description
50001 Ready Playbook Task 11	EnPIs and EnBs

Full Description

SEEC Tips

Saudi organizations can make use of the SEEC Energy Performance Indicator (EnPI) Lite tool to

develop regression analysis-based EnPIs either at the SEU or whole facility (scope and boundaries) level. The EnPI Lite tool is based upon the SEEC 50001 Ready Measurement and Verification Protocol.

Another guidance standard on measuring energy performance is ISO 50006: Energy management systems — Measuring energy performance using energy baselines (EnB) and energy performance indicators (EnPI) — General principles and guidance. ISO 50006 provides practical guidance on how to meet the requirements of ISO 50001 related to the establishment, use and maintenance of energy performance indicators (EnPIs) and energy baselines (EnBs) in measuring energy performance and energy performance changes.

In Saudi Arabia, a relevant variable that is expected to impact the energy consumption of many significant energy uses is average daily temperature, which is best measured using cooling degree days (CDD) or heating degree days (HDD). A good reference for global CDD and HDD data is the Degree Days website (https://www.degreedays.net/), which allows for free downloading of CDD data for different cities across Saudi Arabia (and the world). One note on base temperature: The correct base temperature to use depends on each case such as building use, insulation level, etc. In general, the base temperature for CDD data is defined as the outside temperature above which a building needs cooling. A value in the range of 15 – 20 degrees Celsius is usually acceptable for office buildings, which takes into account both external heat gains (i.e., greenhouse effect) and internal heat gains (people, computers, etc.) that increase indoor temperatures such that they require cooling.

Saudi energy intensive organizations will be familiar with SEEC energy efficiency reporting requirements that utilize metrics of MMBtu/tonne or kWhr/tonne. These organizations are encouraged to develop regression analysis-based metrics to provide additional insights on energy performance. Please contact the SEEC 50001 Ready Help Desk for any questions on developing appropriate regression-based EnPIs.

Establishing energy performance indicators (EnPIs)

Energy performance indicators (EnPIs) are developed using the information from the energy review (Task 8 Energy Data Collection and Analysis). The responsibility for developing a list of potential EnPIs typically is left to the energy team and others assigned to assist. Top management is responsible for ensuring that the EnPIs appropriately represent energy performance. Most often, this is accomplished through the management review process (see Task 23 Management Review).

It may be necessary to develop different EnPIs for different stakeholders. Stakeholder needs can vary significantly, and their requirements should be considered in EnPI development. Top management typically will be interested in an EnPI that is related to your organization's strategic business goals and improves the bottom line. Operations or production personnel may want a metric that provides guidance for operating equipment and systems at maximum efficiency. External agencies may require specific performance metrics to provide information related to regulatory or other requirements.

While there are no limits on the number of EnPIs that your organization can have consider selecting a handful that provide immediate value to key stakeholders. It is recommended that each SEU should

have one associated EnPI. EnPIs should be developed so you have an ability to monitor energy performance and demonstrate energy performance improvement of SEUs and other parts of your organization that are of interest.

ISO 50001 requires organizations to demonstrate energy performance improvement. This requirement necessitates the development of at least one EnPI and EnB. There is no requirement for what scope and boundaries for which energy performance improvement needs to be demonstrated. However, if you are planning on seeking SEEC 50001 Ready recognition for this project please refer to the "Get Ready Recognized," page of the SEEC 50001 Ready Navigator to ensure you select an EnPI, EnB, and method for demonstrating energy performance improvement allowed by the recognition program. To achieve Ready recognition energy performance improvement is demonstrated for the same scope and boundaries as your SEEC 50001 Ready EnMS.

The meaning and usefulness of an EnPI may be enhanced if it is normalized by a relevant variable that affects the energy consumption pertaining to the EnPI. See Task 8 Energy Data Collection and Analysis for additional details on relevant variables

EnPIs are typically established in one of three forms:

- a single metric, such as consumption;
- a ratio or per unit basis such as Btu/square foot or Btu/pound or Btu/unit; or
- a numerical model that accounts for one or more relevant variables.

A single metric, such as consumption, is frequently adequate to determine and monitor energy performance if the equipment, system, or process is not affected by other variables or if the relevant variables are constant. Single metrics are also easily conveyed to those not familiar with the details of energy uses or who wish to connect energy consumption to financial costs and environmental impacts.

Learn More: **Examples of single metrics**

- A warehouse with no heating or cooling, equipped only with lighting, and operating on a set schedule every day would be expected to have consistent energy consumption. Any changes would reflect site changes (e.g., adjusted schedule, site expansion) or changes in energy performance (e.g., installed high efficiency lighting, removed excess fixtures).
- A motor operated 24 hours a day at a constant load would be expected to have consistent energy consumption. A change in consumption may indicate motor problems, or if the current motor is replaced with an energy-efficient motor, a consumption decrease would be expected.

In these examples, monitoring consumption as the EnPI provides guidance on the operational status of equipment or information on the results of changes.

A ratio or a per unit basis EnPI may be desired so it is possible to make comparisons over time at

different output levels or at different locations of a similar process. These EnPIs typically relate energy consumption, cost, or environmental impact to an appropriate organizational output. One form of a ratio EnPI that relates performance to production or to one single output is commonly referred to as *simple energy intensity.* An energy intensity EnPI is defined and calculated by dividing energy consumption by productive output for an organization, site, department, product, equipment, system, process, or other part of the organization under consideration.

When calculating the EnPI, the energy measurement must accurately capture energy consumption for the unit under consideration, and the chosen unit, such as production measure, must cover the same time frame as the energy consumption.

Learn More: **Examples of ratio metrics**

- For a commercial operation, an EnPI may be Btu/occupied-square foot or Btu/type-square foot or use (e.g., a commercial warehouse may calculate an EnPI for refrigerated square footage and another EnPI for dry goods square footage).
- For an industrial plant, an EnPI may be Btu/unit produced or Btu/$-value added to product.
- For an organization that makes bricks, a typical EnPI is Btu/lb or Btu/ton of bricks. A change in this EnPI provides an indication that some parameter in the process has changed and warrants investigation.

A numeric model may provide a more meaningful measure of energy performance than a single metric or simple ratio to accurately represent the relationship between operational activities and energy consumption. In this case, more sophisticated models that allow the use of one or more factors for estimating energy consumption may be required. Depending on your needs, regression analysis or calculations using engineering theory may be required to provide a sufficiently accurate model. Modeling based on regression analysis or engineering theory can be complex, and typically requires analysis by someone skilled in the systems, processes, operations, or equipment being modeled. The Saudi Energy Efficiency Center offers a regression-based tool called the SEEC EnPI Lite tool which can be used to demonstrate normalized energy performance improvement.

Learn More: **Using the SEEC Energy Footprint Tool and SEEC EnPI Lite Tool**

The SEEC EnPI Lite tool is a web based calculator that estimates energy savings relative to relevant variables, like production levels and weather, using linear regression. EnPI Lite provides a user-friendly way for the Saudi market to practice regression-based energy modeling, which is a global best practice to measure a facility's energy performance.

The SEEC EnPI Lite tool requires input using one of two SEEC tools that organize, analyze, and track energy:

1. **The SEEC Energy Footprint Tool**. This comprehensive macro-enabled Excel tool tracks energy consumption, relevant variables, and energy uses. It provides charts for all tracked

data and allows for easy export of data to the SEEC EnPI Lite tool.
    - **Footprint tool inputs:** The Footprint tool can actively track up to 20 types of energy consumption (electricity, natural gas, etc.) and 20 related relevant variables (production levels, degree days, operating hours, occupancy rates, etc.) for up to a 10 year period. Customized energy types and related factors can easily be added as needed. Energy end-use is tracked on an annual yearly basis. Users can create up to 10 major energy end-use groups (process areas, building areas, boiler room, etc.) which each can include up to 30 individual components (boilers, fans, pumps, lights, etc.) which assists in determining the EnMS SEUs.
    - **Footprint tool outputs**: The Footprint tool generates a series of charts and graphs based on the entered data. This allows for the comparison of energy types, monthly and yearly trends, and entered energy consumption (BTUs) vs energy end-use (application of energy). Comparing consumption to tracked end-use can help to determine how accurately the total "bottom-up" end-use compares to the "top-down" metered consumption and how much end-use energy consumption may be unaccounted for. The tool helps to determine the energy consumption of various energy end uses and thus help in determining the SEUs. Finally, the tool can also output energy data into a format that is compatible with the SEEC EnPI Lite tool in order to perform a regression analysis of energy consumption with other relevant variables like weather, production, and building occupancy.
2. **The Energy Consumption Tracker**. This excel-based tool is a simplified version of the SEEC Energy Footprint tool that is not macro-based. The Energy Consumption Tracker allows users to track energy consumption by type (electricity, natural gas, etc.) and related relevant variables affecting energy consumption (production levels, degree days, operating hours, occupancy rates, etc.) on a monthly basis for one or multiple years. The tool can also output energy data into a format that is compatible with the SEEC EnPI Lite tool in order to perform a regression analysis of energy consumption with other relevant variables like weather, production, and building occupancy.

A standard that is useful to reference for guidance on measuring energy performance is ISO 50006: Energy management systems — Measuring energy performance using energy baselines (EnB) and energy performance indicators (EnPI) — General principles and guidance. ISO 50006 provides practical guidance on how to meet the requirements of ISO 50001 related to the establishment, use and maintenance of energy performance indicators (EnPIs) and energy baselines (EnBs) in measuring energy performance and energy performance changes.

Establishing energy baselines (EnBs)

An energy baseline (EnB) is the quantitative reference(s) for comparing current EnPI values to determine if energy performance has improved. Typically, EnBs are associated with EnPIs and represent the value of an EnPI during a time interval known as the *baseline period.* Like EnPIs, the EnB can be established at any level of your organization. An EnB can be established for the entire site and/or there can be baselines for individual equipment, systems, or processes. The following inputs

will help you determine the appropriate EnBs:

- How will each EnPI be used for evaluating energy performance? Is there a logical EnB for each?
- What are the historical changes to site, equipment, systems, processes, or organization that would change how energy performance is evaluated?
- What stakeholder interests should be considered when establishing EnB for the EnPI?
- Are there strategic initiatives that would be measured or influenced by one or more of the established EnPIs? Is there an EnB associated with these strategic initiatives?
- What are the historical periods that have reliable, consistent data for the established EnPIs?

The answers to these questions will help identify the relevant EnBs for the established EnPIs.

Document the methodology for determining and updating EnPIs

Documented information must be maintained on the methods you use to determine and update your organization's EnPIs. Some organizations document their methods within an energy manual, which is not required but can be useful as a "roadmap" to the energy management system (EnMS). Other organizations address their methods for determining and updating EnPIs within an energy planning procedure. How and in what format the documented information is maintained is up to your organization.

EnPI values are reviewed and compared to their respective EnBs, as appropriate. Typically, this is done on a regular basis to ensure continuing applicability for the energy performance being measured. Changes in site, equipment, systems, processes, operating procedures, materials, relevant variables, and many other factors could result in a change in the validity of the EnPI used to measure energy performance. When changes occur, they are evaluated so the EnPI can be updated as needed. Recall that top management is responsible for ensuring that the EnPIs are appropriate for the organization (see Task 4 Management Commitment). As changes occur that affect the validity of the EnPIs, this information is included in Task 23 Management Review.

Determine when EnBs are adjusted

Calculated EnPI values and their associated EnBs are retained as documented information and periodically reviewed to determine if adjustments are required.

The process of updating EnPIs should include an evaluation of the EnBs to determine if they remain a meaningful point of comparison to determine energy performance improvement. Adjustments to an EnB should be made in the following instances:

- When the EnPIs no longer accurately reflect the organization's energy performance
- When there are major changes to static factors, the process, operational patterns, or energy systems
- According to a predetermined method

Records of modifications and updates to EnBs must be retained. Maintaining EnBs keeps the measures of energy performance relevant and meaningful.

Monitor and analyze EnPI values and EnBs

Calculated EnPI values and EnBs should be recorded and reviewed on a regular basis. Updated EnPIs and EnBs are an input to the management review (Task 23 Management Review) and are used to help monitor energy performance and demonstrate energy performance improvement. These metrics can be used to verify the success of activities such as energy-efficiency projects, operator or maintenance personnel energy-efficiency training, and energy management awareness programs. This provides a positive message for middle and top management to build support for the EnMS. Improvements in EnPIs are indicators of growing sophistication of the EnMS. Accurately recording and storing EnPIs and EnBs creates a historical registry that will display the impact of energy management practices over time.

The components of EnPIs that are measured or calculated will be managed for accuracy and repeatability in the energy data collection plan (addressed in Task 8 Energy Data Collection and Analysis). Top management's review of energy performance must include a review of performance as determined by the EnPIs and the related EnBs. Top management must ensure changes are made when these metrics are no longer appropriate.

Learn More: **SEEC EnPI Lite software tool**

SEEC provides the online SEEC EnPI Lite software as a free resource for organizations wishing to use regression modeling to develop normalized EnPIs and calculate energy performance improvement against an EnB. The EnPI Lite uses a set of statistical validity tests documented in the SEEC 50001 Ready M&V Protocol (English | Arabic) to ensure results are mathematically meaningful. The EnPI Lite tool can be used by organizations seeking SEEC recognition as part of the SEEC 50001 Ready program. The SEEC EnPI Lite tool will provide site-level energy savings, energy performance improvement percentage, and energy performance improvement percentage for each energy source.

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