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. If relevant variables significantly affect energy consumption, normalize the EnPIs.
2. Develop an energy baseline (EnB) for 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.

- If you are planning on seeking 50001 Ready recognition for this project please refer to the, “Get Ready Recognized,” page of the 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 50001 Ready EnMS.

Task Overview

Energy performance indicators are quantitative metrics used to monitor energy performance and demonstrate energy performance improvement. As quantitative measures, energy performance indicators (EnPIs) 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

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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.

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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 but needs to be adjusted through the use of an energy intensity, regression, or other adjustment method.

Responsibility for determining the 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 by making the comparison to the EnBs 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

no resources for this questions

Full Description

Establishing energy performance indicators (EnPIs)

Energy performance indicators (EnPIs) are developed using the information from the energy review (Task

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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. If you are planning on seeking 50001 Ready recognition for this project please refer to the, "Get Ready Recognized," page 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 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.

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

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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-optimized 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 or cost 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 U.S. Department of Energy offers a regression-based tool called the Energy Performance Indicator Tool Lite. If you are located outside the US, please consult your program administrators program guide for tools available in your area.

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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:

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- 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 management review (Task 23 Management Review) and 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-optimized projects, operator or maintenance personnel energy-optimization 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: **EnPI Lite software tool**

The online 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 50001 Ready M&V Protocol to ensure results are mathematically meaningful. The EnPI Lite tool will provide site-level site energy savings, energy performance improvement percentage, and energy performance improvement percentage for each energy source. Use of the EnPI tool is not required for 50001 Ready recognition. Other tools are also available.

Decarbonization

Energy performance indicators are quantitative metrics used to monitor energy performance and demonstrate energy performance improvement. As quantitative measures, energy performance indicators (EnPIs) are measured values, ratios, or models your organization accepts as meaningful representations of energy performance.

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When managing energy-related GHG emissions as part of your EnMS, include energy-related GHG performance indicators as quantitative ways to monitor your energy-related GHG emissions. Like other EnPIs, energy-related GHGperformance indicators can be:

- A single metric, such as total emissions
- A ratio or per unit basis, such as pounds of emissions per unit, or
- A numerical model that accounts for one or more relevant variables

When developing performance indicators for energy-related GHG emissions, your organization should consider:

- Using emissions intensity, either from a ratio or from a numerical model, as a meaningful internal metric to manage energy-related GHG emissions and changes in energy-related GHG emissions performance over time.
- Establishing an energy-related GHG performance indicator for each emission type (i.e. Scope 1, 2, and 3) included in your scope and boundaries.
- Establishing at least one energy-related GHG performance indicator for each SEU.
- Setting performance indicators based on stakeholder needs relative to GHG emissions reporting.

In addition to your energy baselines, an energy-related GHG emissions baseline should be developed. The energy-related GHG emissions baseline should provide a quantitative reference for determining if your energy-related GHG emissions have reduced and performance has improved. When developing your energy-related GHG emissions baseline, your organization should consider:

- How the energy-related GHG emissions performance indicators will be used for evaluating GHG emissions performance.
- Whether there is a logical baseline for each energy-related GHG emissions performance indicator.
- Whether there are stakeholder interests to account for when establishing energy-related GHG emissions performance indicators.
- Whether there are strategic initiatives that can drive the formation of energy-related GHG emission performance indicators and baselines.

Establishing a new EnMS prioritizing decarbonization

If you do not have an existing 50001 Ready-based EnMS and want to build one that also helps your organization manage GHG emissions, you should follow the guidance in the “Full Description” tab keeping the following in mind:

1. **Establish energy-related GHG emission performance indicators**. Establish energy-related GHG emissions performance indicators following the guidance above. Keep in mind that different indicators might be needed for different internal and external stakeholders.
2. **Establish energy-related GHG emission baselines**. Establish baselines for any energy-related GHG emissions performance indicators. Ensure the baselines meet both your internal and external stakeholder interests. Records of modifications and updates to both performance indicators and baselines must be retained.
3. **Create a methodology for determining and updating energy-related GHG emissions**

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performance indicators. Create a methodology for determining and updating performance indicators based on the new energy-related GHG emissions performance indicators and baselines. Keep in mind the frequency of GHG-related reporting needed by different GHG emissions-related stakeholders.

4. **Create a methodology for adjusting energy-related GHG emissions baselines.** Create a methodology for reviewing performance indicators and baselines based on the new energy-related GHG emissions performance indicators and baselines.
5. **Create a process for monitoring and analyzing energy-related GHG emissions performance indicators**. Create a process to monitor and analyze EnPIs and energy-related GHG emissions performance indicators. Updates to energy-related GHG emissions performance indicators and baselines should be inputs to the management review (Task 23 Management Review).
6. **Review your process for monitoring and analyzing EnPIs**. Monitor and analyze the energy-related GHG emissions performance indicator values. Updates to energy-related GHG emissions performance indicators and baselines should be included as inputs to the management review (Task 23 Management Review)

Adapting an existing EnMS to prioritize decarbonization

If you have an existing 50001 Ready-based EnMS and want to adapt it to manage energy-related GHG emissions, you should:

1. **Review your current EnPIs and add energy-related GHG emission performance indicators**. Review your current list of EnPIs to determine which additional energy-related GHG emissions performance indicators should be established. Keep in mind that different indicators might be needed for different internal and external stakeholders.
2. **Review your current energy baselines and add energy-related GHG emission baselines**. Establish baselines for any energy-related GHG emissions performance indicators. Ensure the baselines meet both your internal and external stakeholder interests. Records of modifications and updates to both performance indicators and baselines must be retained.
3. **Review your methodology for determining and updating EnPIs**. Review and revise your methodology for determining and updating performance indicators based on the new energy-related GHG emissions performance indicators and baselines. Keep in mind the frequency of GHG-related reporting needed by different stakeholders.
4. **Review your process for adjusting EnBs.** Review your process for reviewing performance indicators and baselines based on the new energy-related GHG emissions performance indicators and baselines.
5. **Review your process for monitoring and analyzing EnPIs and energy-related GHG emissions performance indicators**. Updates to energy-related GHG emissions performance indicators and baselines should be included as inputs to the management review (Task 23 Management Review).

Commercial ERP

The guidance for this task is from the following sections from the ERP Framework: ERP Framework

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Milestone 2.

As mentioned earlier in Task 8 (Energy Data Collection and Analysis), the IMP ensures standardization and repeatability in methods of calculating and reporting GHG emissions year over year by documenting the organization's process for data management, methods to quantify emissions and methods for auditing and verification. Make sure that the IMP clearly defines energy performance indicators as well as energy baselines and methodologies for determining and updating them.

Next, select the key characteristics that will be used to prioritize and categorize the buildings in the portfolio. When selecting characteristics, consider what differentiates buildings within the portfolio. An organization with similar building types across the country might identify climate zone and energy prices as key characteristics, while an organization with many buildings in one location might identify building type and HVAC system as key characteristics. The table below lists common building characteristics that can be used to help prioritize and categorize buildings in the portfolio. GHG emissions intensity or site energy use intensity should always be selected as a characteristic. (Milestone 2)

Most Common Building Characteristics Used in Portfolio Categorization

Characteristic	**Guidance for Selection of Characteristic**
GHG emissions intensity (lbs. CO_2e/ft^2)	Benchmark GHG emissions intensity (GHGI) between similar building types that are different sizes by normalizing across square footage. This information is used to determine which buildings within the same building type have the highest GHG intensity.
Total GHG emissions (tons CO_2e)	Rank buildings by total GHG emissions. This information is used to identify buildings that are the largest contributors to the portfolio's emissions.
Site energy use intensity (kBtu/ft^2)	This is used to benchmark energy use at the building so buildings of various sizes can be compared.
Total energy use (kBtu)	Identify buildings that are the largest contributors to the portfolio's energy use.
Planned renovations / equipment end-of-life	Ensure planned investments are designed to be low to no carbon.
Building type	Group similar building types to apply similar strategies.
On-Site Fossil Fuel Combustion (% energy use or kBtu/ft^2)	Identify buildings where on-site fossil fuel combustion is a significant contributor to the building's total emissions
HVAC system type	A high-level categorization (e.g., district vs. distributed, hydronic vs. air, fuel type) should be used when there are a range of system types requiring decarbonization strategies.
Climate zone	Different technical approaches may apply based on climate zone (e.g., cold climate heat pumps and envelope measures). Select representative buildings in the range of climate zones in which the portfolio is located.
Ownership structure	Ownership/management/lease structures may result in differences in utility payment responsibility, so categorizing by ownership structure can be a useful characteristic.
Disadvantaged Communities	Determine if buildings are located within disadvantaged communities and consider these buildings for investment.

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Energy prices	Prioritize buildings with the highest energy prices.
Regulatory drivers	Prioritize locations with building performance standards, benchmarking and decarbonization ordinances, strong building codes, and potential financial penalties or taxes.
Utility grid carbon intensity	Prioritize overall GHG emission reduction efforts in regions with high grid carbon intensity and prioritize electrification in regions with lower grid carbon intensity.
Utility incentives and funding opportunities	Prioritize locations with utility programs and grants that support electrification and building efficiency improvements.

Many organizations find it useful to pair either GHGI and total GHG emissions or EUI and total energy use so that both total emissions and emissions intensity are captured. Though organizations are more familiar with a site's EUI than GHGI, EUI does not adequately capture the difference in emissions intensity between different fuels (such as natural gas and electricity) or the variation in electrical grid carbon intensity between regions. Organizations can apply the same emissions factors used in their GHG inventory to calculate GHG intensity on a building level. However, some organizations may find EUI more readily available at this step of their emissions reduction planning efforts. If EUI or energy use are selected as a characteristic, then an additional characteristic such as on-site fossil fuel combustion should be included to help portfolios target high natural gas-consuming buildings. (Milestone 2)

Other common characteristics include building type, HVAC system type, and climate zone. These characteristics can be paired to identify solutions appropriate to specific groups of buildings. For example, an organization may look at groups of buildings that have packaged gas-fired units in warm climates and packaged gas-fired units in cold climates to identify appropriate heat pump solutions for both groups of buildings. Additionally, organizations may want to consider groups of buildings with and without planned renovations or major equipment reaching end-of-life. This will ensure that strategies for both situations are identified. (Milestone 2)

Industrial ERP

Establishing a baseline is as important for GHG emissions as it is for energy, and that GHG emissions baseline will be determined based on the GHG inventory. Comparing the baseline GHG inventory to emissions reduction potential and achieved targets can serve as performance indicators for emissions reductions.

The guidance for Task 11 is found within the following sections of the ERP Industrial Framework:

Milestone 1:

Establish a greenhouse gas inventory management plan – Develop and document standardized data management processes and methods to collect, quantify, verify, and roll up emissions data from the facility level to the portfolio level to create a GHG inventory. Many organizations may have already completed a GHG inventory and have these processes in place; it may be worth revisiting them for completeness, however. Inventories should follow the Greenhouse Gas Protocol and cover all significant sources of GHG emissions. At a minimum, inventories must include all direct emissions from sources

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owned or operated by the organization, such as boilers, furnaces, and vehicles (Scope 1) as well as indirect emissions associated with purchased energy such as electricity (Scope 2). In addition to energy-related emissions, Scope 1 emissions may also include non-energy emissions, such as direct process emissions from certain industrial processes or leaks of fluorinated gases or other GHGs. Indirect emissions that occur in the value chain, both upstream and downstream, may also be included (Scope 3).

Define evaluation criteria – Emission reduction potential is the amount a given project, measure, or scenario will reduce GHG emissions, relative to the baseline. In general, this should be the primary metric considered by plan developers; functionally, it is the metric that defines success or failure of the plan. Emission reduction potential of individual projects will likely depend on what other projects are implemented (e.g., electrifying a thermal process will have a greater emission reduction potential if the facility is powered by renewable electricity). Other considerations will be important as well, depending on organizational priorities.

Milestone 2:

Characterizing the portfolio by magnitude of emissions, organizations should select other useful characteristics to sort or order their portfolio. This allows an organization to direct its focus, understand commonalities across the portfolio, and identify key metrics they can use to benchmark performance. Finding commonalities via a methodical portfolio characterization will ultimately enable organizations to quickly scale the implementation of decarbonization projects via repetition of successful strategies across similar systems or facilities.

Benchmark SGEs - Benchmark SGEs relative to similar systems to gauge performance. This can be done internally (e.g., across facilities within the same portfolio) or externally, depending on data availability. In the absence of reliable data on comparable systems, SGEs can instead

be benchmarked against their own past performance. Benchmarking can be used to identify best practices and ideal operating conditions as well as opportunities for performance improvement.

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