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ENGINEERING & TECHNOLOGY

ISO 50001:2018 Energy Management System (EnMS)

Implementation Training

Date: 1/4/2026

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Energy Management Experts

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Ts. Visnu Varatan, MEng, REM II

Director of Digital Oceans Malaysia

- Completed M.Eng in Industrial Engineering at University Malaya.
- Energy Manager with 6 years of experience in optimizations and energy management.
- Conducted Energy Audit for 5 sites with and without EACG 2.0.
- Energy Assessment and Energy Audit for Daikin Malaysia Sdn Bhd, Abbott Sdn Bhd, Spritzer Mineral Water Sdn Bhd, Nestle, Dutch Lady, Duopharma, Oleon Chemicals, Kimberly Clark, Grand Carpet, Publika Mall and more.

Ts. Zuhair, REA, REM

Registered Energy Auditor

REGISTERED ENERGY AUDITOR

- Completed B.Eng in Electrical and Electronic in University of East London
- Energy Manager with 8 years experience in energy management.
- Registered Energy Auditor with completed EACG 2.0 Grant Energy Auditor for Manufacturing plants and hotels with all together 13 sites.
- Handled energy efficiency projects up to 3.5 Million in value.

ISO 50001 TRAINING AGENDA

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9.00 am — Introduction & Training Objectives

9.15 am — Energy Management Fundamentals & ISO 50001 Overview

9.45 am — ISO 50001 Requirements & EECA 2024 Alignment

10.30 am — Break

10.45 am — EnMS Gap Analysis & Energy Review (Workshop)

11.45 am — Scope, Boundary & SEU Identification (Workshop)

1.00 pm — Lunch Break

2.00 pm — EnB, EnPI & Energy Profile Development (Workshop)

2.45 pm — Energy Saving Measures (ESM) & Action Plan (Workshop)

3.30 pm — Break

3.45 pm — Energy Monitoring, Tools Demo & Performance Evaluation

4.30 pm — Documentation & Reporting Requirements

4.45 pm — Discussion & Next Steps

5.00 pm — End of Training

Introduction to ISO50001

Training Objectives

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- ✓ Understand ISO 50001 implementation approach
- ✓ Learn how to conduct energy review
- ✓ Identify Significant Energy Users (SEU)
- ✓ Develop EnPI & EnB
- ✓ Create actionable energy improvement plan

Why Energy Management?

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1. Rising Energy Costs in Malaysia
Increasing electricity tariffs and fuel price volatility
Higher operational expenses affecting profitability
Need for cost optimization through energy efficiency

2. Regulatory Compliance (EECA 2024)
Mandatory compliance under Energy Efficiency and Conservation Act (EECA) 2024
Requirement for energy audits and reporting
Risk of penalties for non-compliance

3. Improve Operational Efficiency
Reduce energy waste across systems and processes
Optimize equipment performance and lifecycle
Enhance productivity with lower energy input

4. Reduce Carbon Emissions
Support Malaysia's sustainability and ESG goals
Lower carbon footprint and environmental impact
Improve corporate image and stakeholder trust

What is ISO 50001?

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- ✓ An international standard developed by International Organization for Standardization
- ✓ Provides a structured framework to manage and improve energy performance
- ✓ Focuses on systematic, continuous improvement of energy efficiency, use, and consumption
- ✓ Helps organizations reduce energy costs and carbon emissions
- ✓ Applicable to all industries and organizations, regardless of size or sector

Example: Energy Management Team

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Chairman

Top Management Representative

Chairman

Energy Manager (REM)

Coordinator / Secretary

Procurement

- Procurement activities of projects, services and goods
- Vendors communications & evaluation

Facilities/ Maintenance

- ESMs from O&M activities
- Operational Controls

Administration & HR

- Administration, training & awareness
- Communication

Engineering/Project

- Energy performance improvement opportunities from technical designs/supports

Production

- ESMs from process improvement opportunities
- Production data

Composition will vary with organization & culture & size will vary.

Roles & responsibilities must be **clearly discussed, defined & agreed!**

PDCA Cycle in EnMS

PLAN

- Energy Review & EnPI, EnB
- Set Objectives & Targets
- Action Plans

DO

- Implementation
- Operational Control
- Training & Awareness

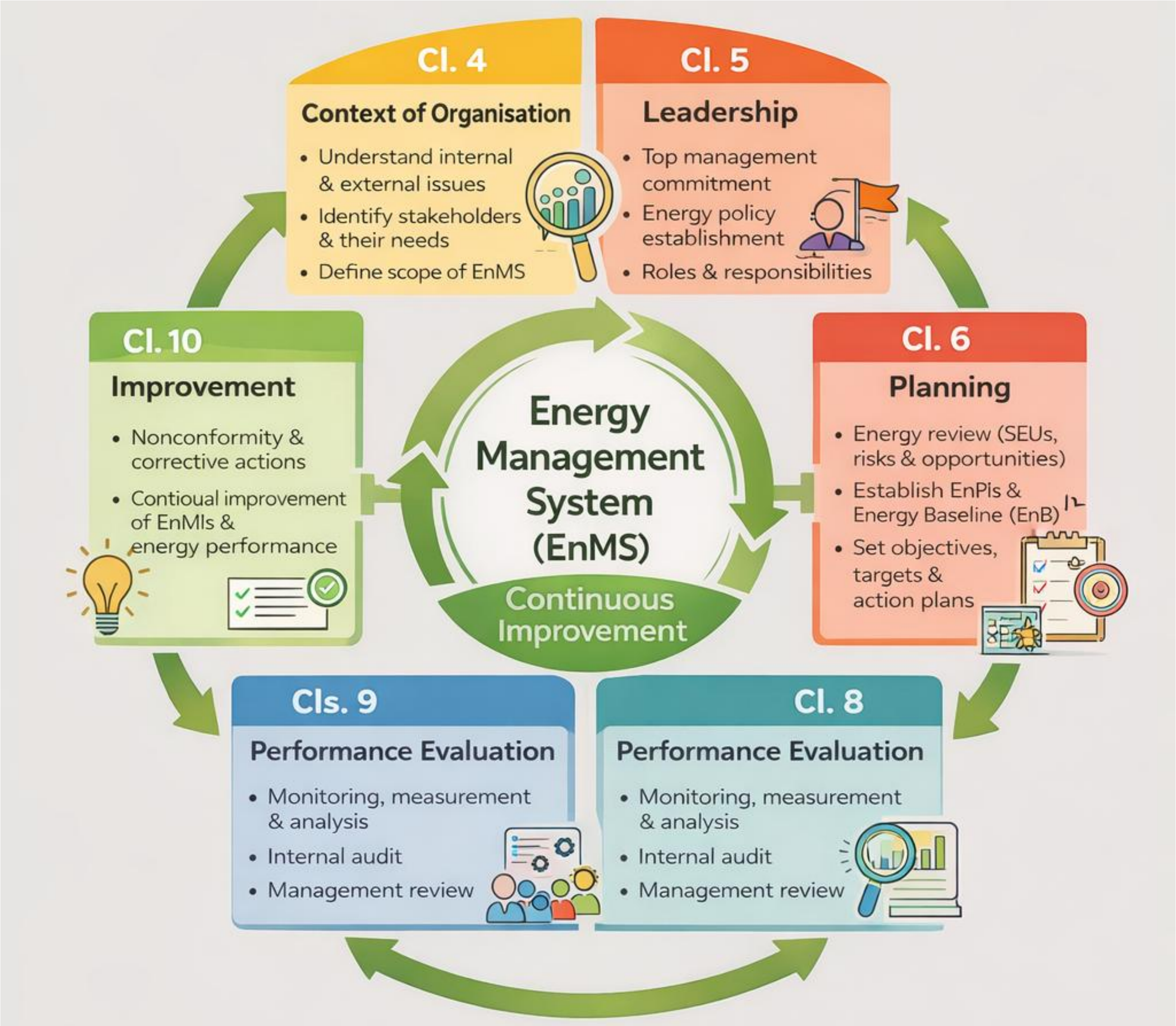
ACT

- Improvement Actions
- Corrective Measures
- Management Review

CHECK

- Monitoring & Measurement
- Internal Audits
- EnPI Analysis

Key ISO 50001 Clauses



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Example

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Clause 4: Context of Organisation
Understand your environment
Example:
•Factory identifies high electricity cost as key issue
•Stakeholders: management, tenants, regulators

Clause 5: Leadership
Management must lead
Example:
•Director signs Energy Policy
•Assign Energy Manager

Clause 6: Planning
Plan how to save energy
Example:
•Identify SEU → Air compressors
•Set target: Reduce energy by 10%
•Define action: Fix leaks, optimize pressure

Clause 7: Support
Provide resources & training
Example:
•Train technicians on energy-saving practices
•Install energy meters & monitoring tools

Clause 8: Operation
Run operations efficiently
Example:
•Schedule machines to avoid peak tariff
•SOP for turning off idle equipment

Clause 9: Performance Evaluation
Check results
Example:
•Track kWh/ton production (EnPI)
•Monthly energy performance review

Clause 10: Improvement
Keep improving
Example:
•Fix issues from audits
•Upgrade to energy-efficient motors

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ENMS Framework (Implementation Flow)

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EnMS Implementation Flow

- ✓ **Energy Review** = “Where is energy used?”
- ✓ **SEU** = “Which equipment uses the most?”
- ✓ **EnPI** = “How do we measure performance?”
- ✓ **EnB** = “What is our starting point?”
- ✓ **Action Plan** = “What do we improve?”
- ✓ **Monitoring/Measurement** = “Did we improve or not?”

Energy Audit vs EnMS (ISO 50001)

Key Differences at a Glance

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	Energy Audit	EnMS (ISO 50001)
Nature	**One-time / Periodic** Snapshot in time	**Continuous** Ongoing system (PDCA cycle)
Focus	**Identify energy savings** Finds issues & opportunities	**Manage & sustain energy performance** Drives continual improvement
Output	**Report with recommendations** Suggestions only	**Management system + improvement** Structured approach with results
Frequency	**Once / Periodic** Limited to audit schedule	**Daily / Monthly monitoring** Continuous tracking & review
Standard / Framework	**Guidelines (MS 1525 / ASHRAE)** Technical reference documents	**ISO 50001** Certifiable management system standard
Data Use	**Analysis (no continuous tracking)** Evaluated during the audit	**EnPI, EnB & continuous tracking** Measured regularly for performance
Improvement	**Improvement not sustained** No system to ensure continuation	**Improvement is sustained** Systematic & long-term
Responsibility	**Auditor-driven** Led by external auditor/consultant	**Management-driven** Led by organization's leadership & team

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Energy Policy

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What is an Energy Policy?
A formal statement by top management that defines the organization's commitment to energy performance improvement.

Key Commitments

✓ **Continuous Energy Performance Improvement**

Reduce energy consumption

Improve energy efficiency across operations

✓ **Compliance with Legal & Other Requirements**

Follow regulations (e.g. Energy Efficiency and Conservation Act 2024 Malaysia)

Meet internal & external obligations

✓ **Support Energy-Efficient Procurement**

Purchase energy-efficient equipment & services

Consider lifecycle energy performance

Example Statement

"We are committed to continuously improving our energy performance, complying with all applicable legal requirements, and supporting the procurement of energy-efficient products and services."

Energy Policy is the **foundation of ISO 50001** — without top management commitment, the system will fail.

Get Top Management Commitment

- ✓ Policy must be approved by CEO / Plant Director
- ✓ Shows leadership involvement

Understand Your Energy Use

Focus on:

- ✓ Major equipment (boilers, compressors, chillers, motors)
- ✓ Identify Significant Energy Uses (SEUs)
- ✓ Example:

  Air compressors = 30% energy

  HVAC = 25% energy

Include Mandatory ISO 50001 Requirements

Your policy MUST include:

- ✓ Commitment to energy performance improvement
- ✓ Commitment to legal compliance (e.g. Energy Efficiency and Conservation Act 2024 Malaysia)
- ✓ Support for energy-efficient procurement
- ✓ Support for design improvements (important for factories)
- ✓ Availability of information & resources

Make It Relevant to Manufacturing

Add industry-specific points like:

- ✓ Reduce machine idle time
- ✓ Improve compressed air efficiency
- ✓ Optimize production scheduling
- ✓ Reduce energy per unit production

Communicate & Display

- ✓ Place poster or memo or banner at factory entrance, office, production floor
- ✓ Share during training and toolbox talks

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ENERGY POLICY STATEMENT (Example)

We are committed to improving energy performance across all our manufacturing operations by implementing an effective Energy Management System in line with ISO 50001.

We shall:

- ✓ Continuously improve energy efficiency and reduce energy consumption in our processes, equipment, and facilities
- ✓ Ensure compliance with all applicable legal and other requirements related to energy use
- ✓ Support the procurement of energy-efficient products, services, and technologies
- ✓ Promote energy-efficient design and operational practices in manufacturing processes
- ✓ Provide necessary resources, information, and training to achieve energy objectives
- ✓ Establish and review energy performance indicators (EnPIs) and targets
- ✓ This policy shall be communicated to all employees and made available to relevant stakeholders.

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GAP Analysis

What is GAP Analysis?

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Definition:

A structured comparison between current energy management practices and the requirements of ISO 50001.

Purpose:

- ✓ Identify gaps (missing or weak elements)
- ✓ Understand current level of compliance
- ✓ Prepare roadmap for implementation

Key Steps:

1. Review existing processes & documentation
2. Compare with ISO 50001 requirements
3. Identify non-conformities / gaps
4. Prioritize actions for improvement

Example:

- ✓ No documented **Energy Policy** → Gap
- ✓ No defined **EnPIs** → Gap
- ✓ No monitoring system → Gap

Outcome:

- ✓ Clear action plan for ISO 50001 implementation
- ✓ Faster certification readiness

Purpose

Understand Readiness Level

- ✓ Evaluate current energy management practices
- ✓ Determine how far the organisation is from ISO 50001 compliance

Identify Improvement Areas

- ✓ Highlight missing processes, documentation, and controls
- ✓ Detect inefficiencies in energy use and management

Prioritise Implementation Steps

- ✓ Focus on high-impact gaps first (e.g. SEUs, EnPIs)
- ✓ Develop a structured action plan for implementation

Industrial Gap Analysis (F&B Manufacturing Plant)

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Area	Current Practice	ISO 50001 Requirement	Gap
Energy Policy	No formal policy	Documented policy approved by top management	Missing Policy
Energy Review	Utility bill tracking only	Detailed review with SEUs identified	Incomplete Review
EnPI	No indicators	Defined EnPIs (e.g., kwh/fon production)	No EnPIs Set
Monitoring	Monthly total consumption	Continuous monitoring (*Sub-metering required*)	Lack of Monitoring
Action Plan	No structured plan	Objectives, targets & action plans	No Action Plan

Major gaps in system, data visibility & compliance

Requires structured EnMS implementation

Pharmaceutical Manufacturing Plant (HVAC & Cleanroom)

Cleanroom Production Area

Air Handling Units & Chilled Water System

Observations

- AHUs running at constant speed (no VSD)
- Overcooling in cleanroom
  → *Temp lower than required*
- *Doors frequently opened → Pressure loss*

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Data Collection

- Chilled Water Consumption (kwh)
- AHU Operating Hours
- Room Temp & Humidity Logs
- Production Batch Schedule

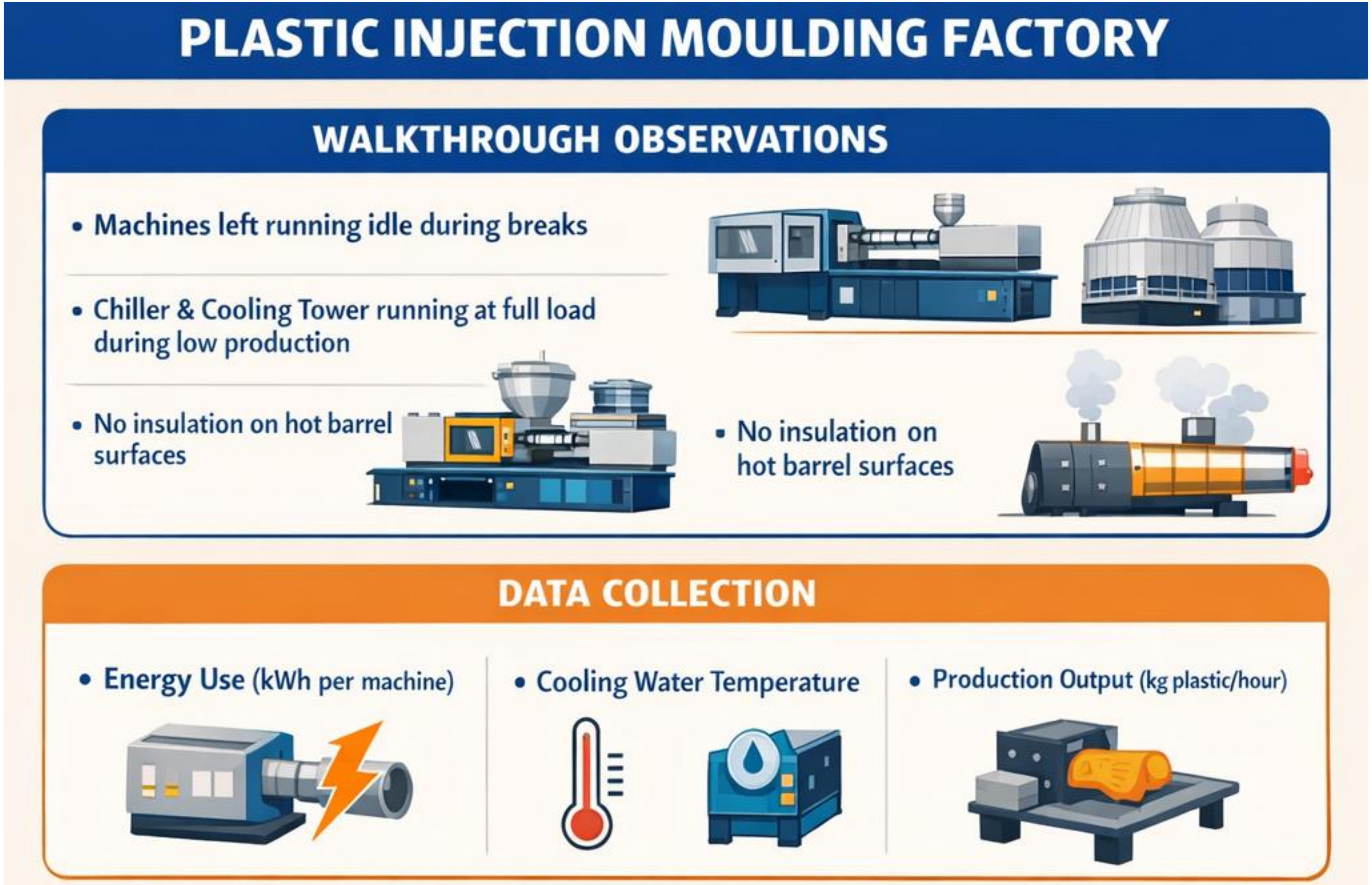
SEUs Identified

HVAC SYSTEM (Major Energy Consumer)

- No optimisation of airflow (Clause 8.1)
- No EnPI (kWh/m^2 Cleanroom)
- No linkage HVAC & Production Schedule

Improvement Actions

- Install VSD for AHUs
- Reset Temperature Setpoints
- Define EnPI: kWh per Batch



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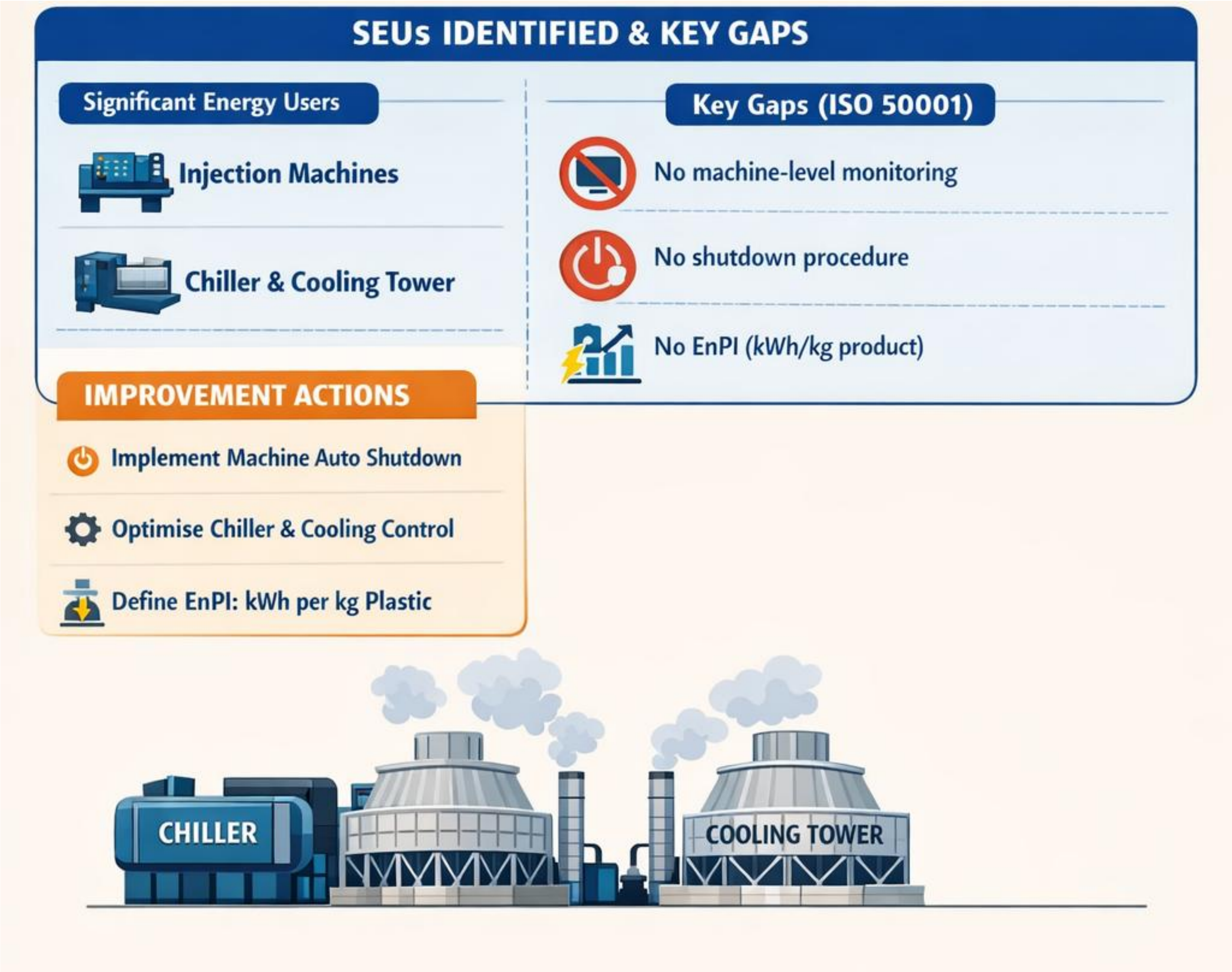

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Cooling Tower (Water Chiller System)

EnMS Gap Analysis – **SEU Focus**

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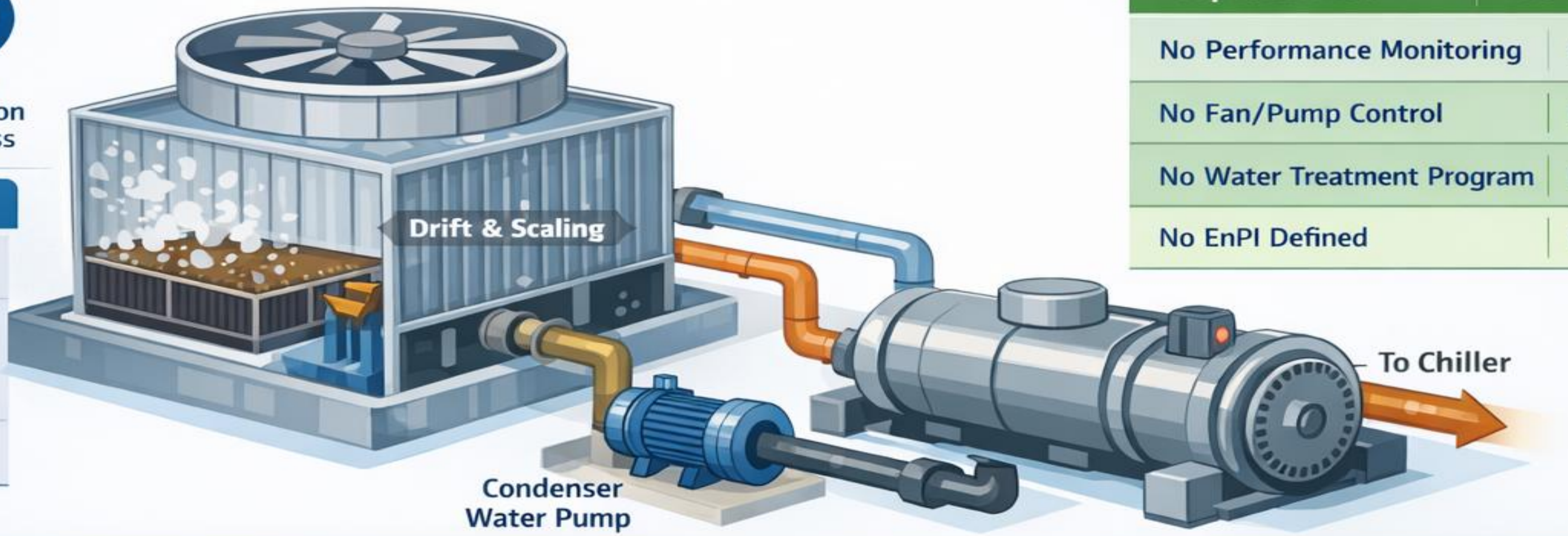
System Overview

- Cooling Tower Fan Motor
- Condenser Water Pump
- Heat Rejection Process

Key Observations

- Fan Running at Constant Speed
- Excessive Drift & Water Loss
- High Basin Temperature (>30°C)
- Scaling & Fouling



Gap Analysis

Gap Identified	ISO Clause
No Performance Monitoring	Clause 6.6
No Fan/Pump Control	Clause 8.1
No Water Treatment Program	Clause 8.1
No EnPI Defined	Clause 6.4

Improvement Opportunities

Control Optimization

- Install VSD on Fan
- Auto Fan Control

Water System Efficiency

- Enhance Water Treatment
- Clean/Replace Fills

Energy Performance (EnPI)

- kW/RT (Chiller)
- CT kW/Ton Heat Rejected

↑ Chiller Efficiency | ↓ Fan & Pump Energy Use | ↓ Condenser Temp | ↑ Equipment Lifespan

Reduce System Energy by 5–15%

Key Taken:

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- Different industries, but same pattern of gaps.
- Most companies don’t lack data — they lack structured EnMS approach.
- Gap analysis helps convert observations into actionable improvements.

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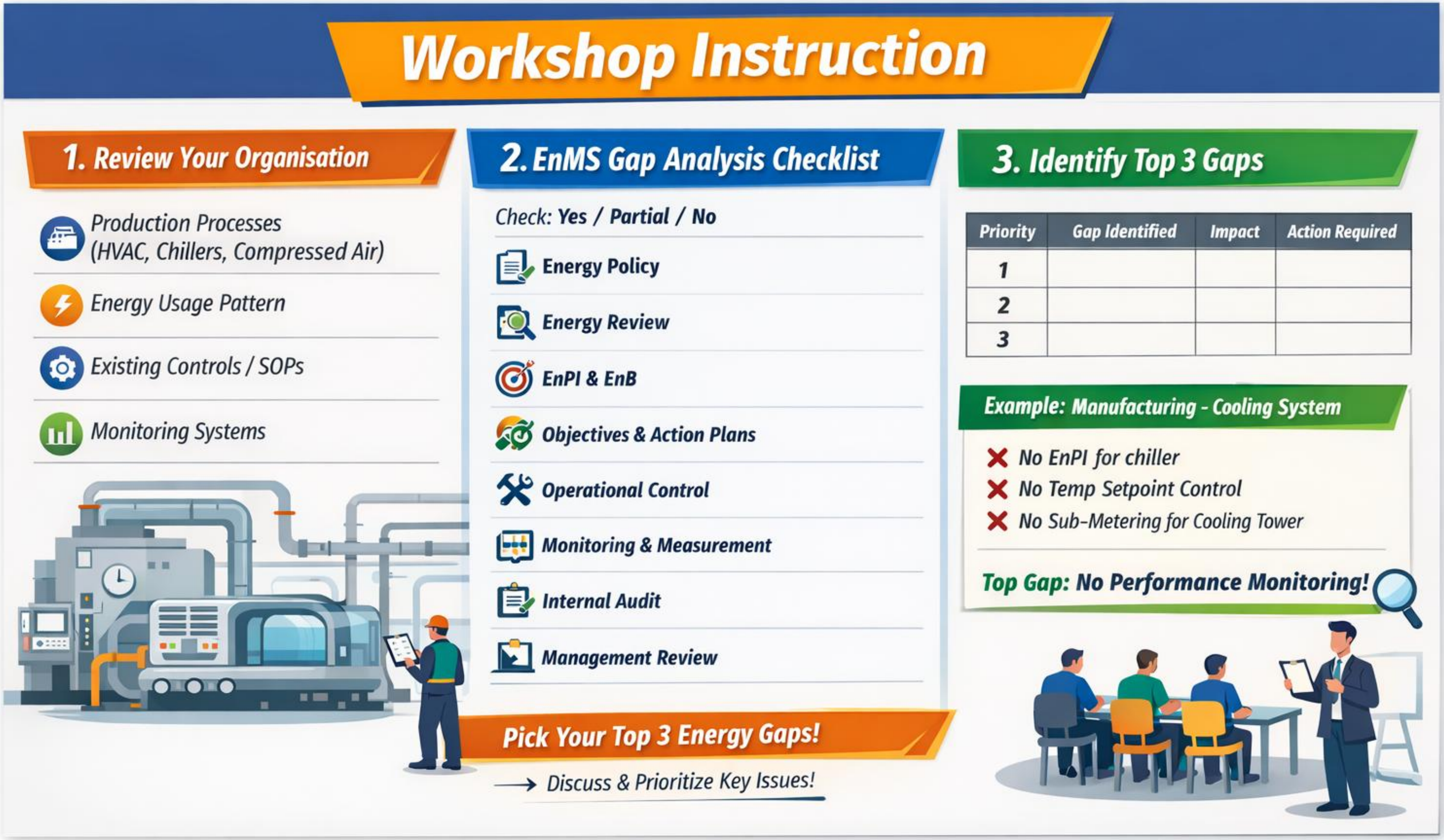
ISO 50001 EnMS Gap Analysis

Requirement	Status	Remarks / Document References
Risks, Opportunities & Mitigation Actions Identfier for EnMS	✗ Not Available	SHE procedure exists, but not specific to energy management activities
Objectives and Targets (including SEUs) Established & Action Man →	✗ Not Available	Target value indicated (projected energy cost saving at RM 200,000 in 2025). However, detailed action not available yet
Energy Review Process Documented & Conduced	✗ Not Available	Documented process to conduct energy review not not available
Current Energy Use and Consumption Analysed	✗ Not Available	Only electricity and solar energy resourced documented and monitored. However, consumption trends evaluation or reviews not performed, only data compiiation available.
SEUs, Variables & Trained O&M Personnel Identified	✗ Not Available	SEUs and variables not identified. No energy efficiency training conducted for personnel involved in O&mn ov SEUs.
Energy Performance Indicators (EnPIs) & Energy Baselines Established	✗ Not Available	No energy performance improvement opportunities es been formally approved for 2024 and
Static Factors Identified	✗ Not established	Not established.
Data Collection Plan for SEUs & Relevant Parameters Documented	⚠ Not Partial	Data collection plan not established. Energy meters only available at building level but not for major energy-using systems and equipment.
Measurement Accuracy & Calibration	✓ Partial	Some SEUs equipment calibrated.

No Energy Review | **No EnPI / EnB** | **No Monitoring Framework**

Major Gaps Identified! Time to Act!

- Focus on **Clause 6 (Planning)** &
- **Clause 9 (Performance Evaluation)**



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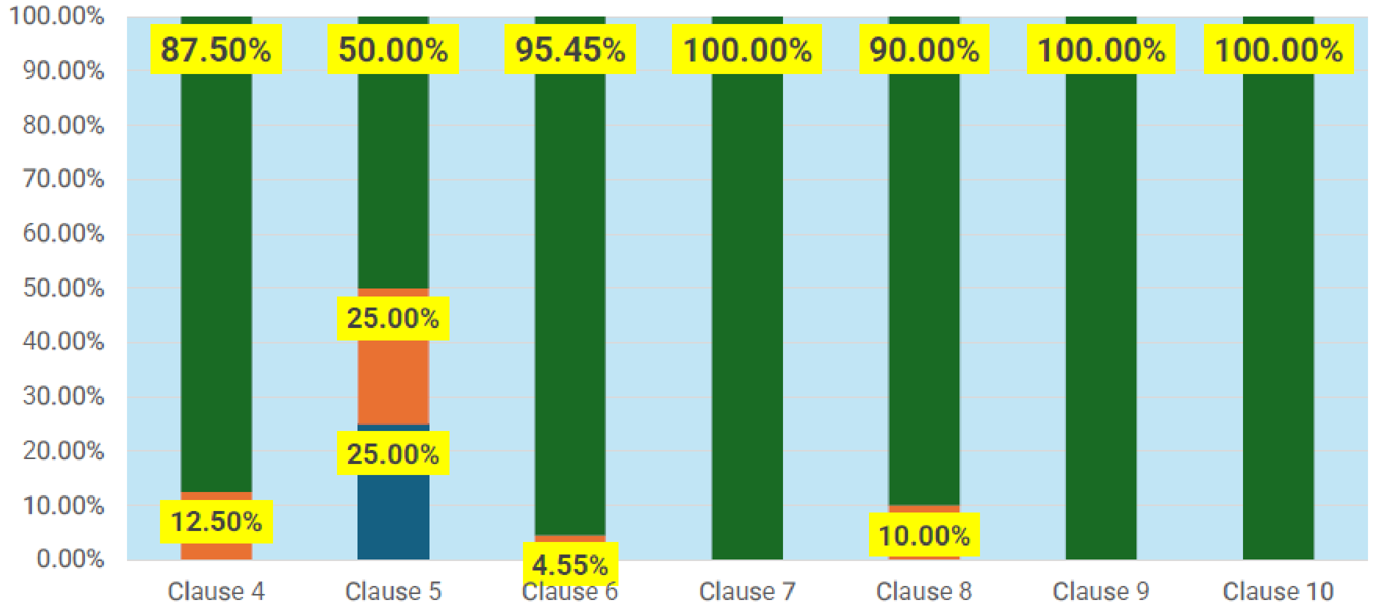
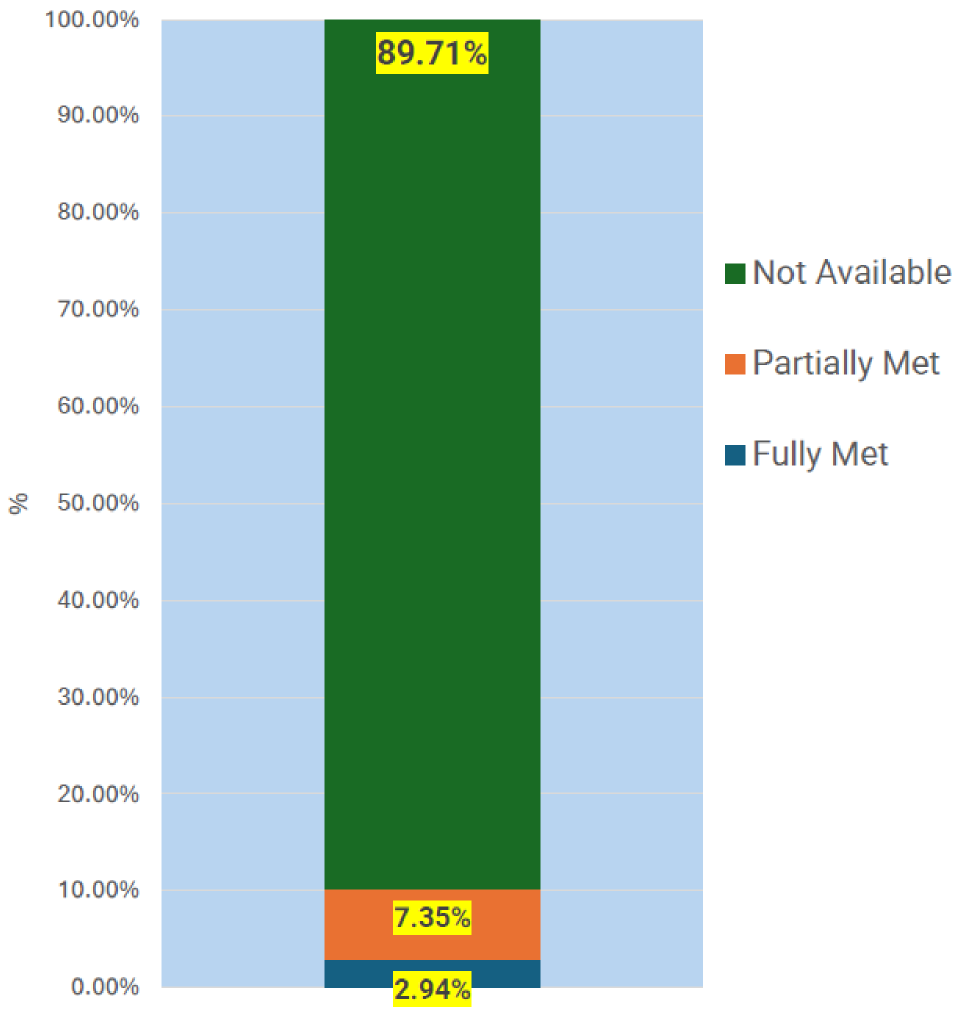
Results

Clause	Total Requirements	Fully Met	Partially Met	Not Available	Compliance Status (%)
4-Context	4	0	1	3	12.50%
5-Leadership	4	1	2	1	50.00%
6-Planning	11	0	1	10	4.55%
7-Support	4	0	0	4	0.00%
8-Operation	5	0	1	4	10.00%
9-Performance Evaluation	5	0	0	5	0.00%
10-Improvement	1	0	0	1	0.00%
Overall System	**34**	**1**	**5**	**28**	**10.29%**

Compliance status based on the Gap Analysis by Clause



Overall Compliance status based on the Gap Analysis by category



Scope and Boundaries

What is Scope?

Defines which parts of the organisation are covered under the Energy Management System (EnMS).

Purpose

- ✓ Ensure clear focus for implementation
- ✓ Avoid confusion during audit & certification
- ✓ Align with organisation objectives

Examples

Entire manufacturing plant

Only production lines (e.g., Injection Moulding Area)

Utility systems (e.g., Chiller + Compressor room)

Good Practice

- ✓ Keep scope realistic & manageable
- ✓ Avoid too narrow scope (miss energy impact)
- ✓ Ensure scope reflects significant energy use

If you had to start small, which area gives the biggest energy saving impact?

What is Boundary?

Defines **limits within the selected scope**

1. Physical Boundary

✓ Buildings (Factory A, Warehouse, Office)

✓ Equipment (Chillers, Boilers, Compressors)

✓ Infrastructure (Lighting, HVAC, Pumps)

2. Operational Boundary

✓ Processes included (Production, Packaging)

✓ Activities (Startup, Shutdown, Maintenance)

✓ Working hours / shifts

Example

Scope: Entire factory

Boundary:

✓ Physical → Production + Utility Block

✓ Operational → 24/7 production + maintenance activities

Common Mistake

❌ Including office in scope but excluding its energy data

❌ Not defining shift operations

Identify All Energy Inputs

List all types of energy used within the defined boundary:

Why Important?

- ✓ Understand energy mix
- ✓ Identify cost drivers
- ✓ Support renewable integration

Typical Energy Sources

- ✓ Electricity (Grid / TNB supply)
- ✓ Natural Gas / LPG
- ✓ Diesel (Generators, Boilers)
- ✓ Renewable Energy (Solar PV, Biomass)

Example (Manufacturing Plant)

Energy Source	Usage
Electricity	Motors, HVAC, lighting
Gas	Boilers, ovens
Diesel	Backup generator
Solar	Rooftop PV system

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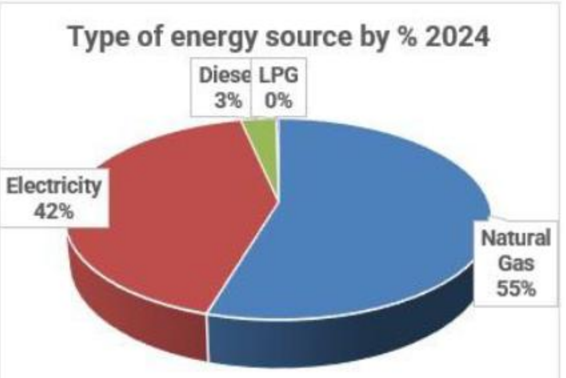
Types of energy use & the energy unit

Energy form	Unit	Conversion factor * to selected energy unit
Gas	GJ	
Electricity	MWh	
Fuel oil	Tonnes	
Coal	Tonnes	
LPG	kl	
Automotive Diesel Oil	kl	

*** Conversion factors are subject to local variations-should be obtained from published data appropriate to the specific locality/type of fuel properties**

Example of EnMS Scope : Sources of energy

Type of energy source	Energy Consumption 2024	
	kWh	%
Natural Gas	14,631,956.15	54.63%
Electricity	11,246,847.51	41.99%
Diesel	849,520.56	3.17%
LPG	57,558	0.21%
Total	**26,785,882**	**100%**



Source: MAREMA

Energy Review & SEU

Determine Significant Energy Uses(SEUs)

Energy use accounting for substantial energy consumption &/or offering considerable potential for energy performance improvement-ISO50001:2018

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WHY?

To establish where most of the organization's energy is being used

Will give the organization idea on the priority area to focus most & get potential energy savings

If the sub-meters have been installed – can compare the calculated & actual result measured by sub-meters

How to quantify each energy use?

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Sub-metering

- This is the best situation
- Ideally automatically logged to a database
- Manually read also gives good information
- Are meters accurate and working
- Is data collection working and accurate

Do you have local meters?

- kW, A, flowrate, etc.
- Can be read manually and calculated/estimated
- Care with time of readings

Quantification or estimation of use

- Motor List
- Heat Balance

Develop the inventory of operation system and M&E services

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Develop the equipment/asset list

- Name of equipment
- Location
- Rated energy capacity (kw/HP)
- Sub meter(Yes/No)
- Operating hours per day
- Operating days per year
- Operational status (in-use/stand-by/not working)

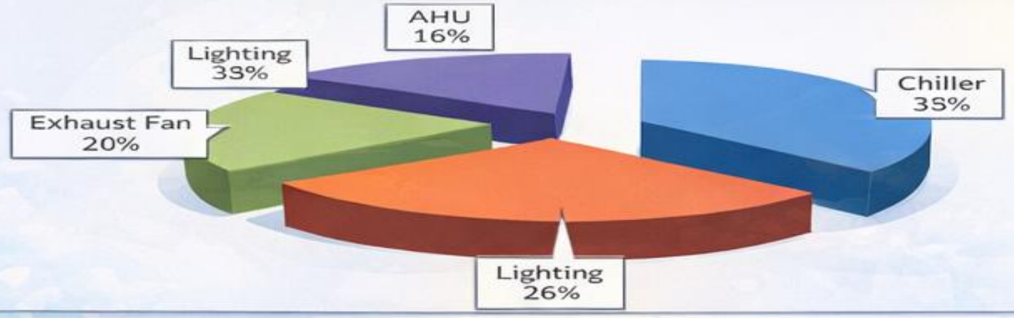
Name of equipment	Year	Plant	System	Name of equipment	Running/ stand-by/ not operating*	Rated Power (kW)	Currently with sub-energy meter* (Yes/No)	Operating hours/day (hrs)	Scaling Factor	Assumptions/ notes
	2024	Plant 1	Compressed Air System		Running	160.00	Yes	7,012.50	1	Measured & Calculated
	2024	Plant 1	Compressed Air Compressor 1		Running	160.00	Yes	7,012.50	1	Measured & Calculated
	2024	Plant 1	Compressed Air Compressor 2		Running	160.00	Yes	7,012.50	1	Measured & Calculated
	2024	Plant 1	Air Dryer 1		Running	4.60	Yes	7,012.50	1	Calculated
	2024	Plant 1	Air Dryer 2		Running	4.60	No	7,012.50	1	Calculated
	2024	Plant 1	Cooling Tower System		Running	5.50	Yes	7,012.50	1	1,347,097.27
	2024	Plant 1	Cooling Tower System		Running	5.50	No	7,012.50	1	112,379.73
	2024	Plant 1	Cooling Tower 1		Running	5.50	No	7,012.50	1	32,257.50
	2024	Plant 1	Cooling Tower 2		Running	5.50	No	7,012.50	1	38,568.75
	2024	Plant 1	Cooling Tower 3		Running	11.00	No	7,012.50	1	38,569.75
	2024	Plant 1	Cooling Tower 4		Running	11.00	No	7,012.50	1	77,137.50
	2024	Plant 1	Cooling Tower 5		Running	11.00	No	7,693.75	1	77,137.50
	2024	Plant 1	Cooling Tower 6		Running	11.00	No	7,012.50	1	77,137.50
	2024	Plant 1	Cooling Tower 7		Running	11.00	No	7,012.50	1	77,137.50

Record operational status & sub energy meter use for accurate tracking.

Examples : The identification of SEUs estimated from energy consumption data from equipment inventory list & energy sub-meters

Name of Equipment	Description		% of Overall Usage
Chiller	4,553,900 kWh/yr	38%	**SEU1**
Lighting	3,131,384 kWh/yr	26%	**4** Rank
Exhaust Fan	2,462,655 kWh/yr	20%	
AHU	1,890,858 kWh/yr	16%	
Total	12,038,088 kWh/yr	**100%**	

Electricity Consumption (kWh) by Equipment



Name of Equipment	Energy Consumption (kWh)	% of Overall Usage	SEUs and Ranking
P1 Drying Oven System	14,631,956.15	54.01%	SEU1
P1 Conventional Printing & Coating Line	1,781,906.91	6.58%	SEU2
P1 Compressed Air System	1,459,477.00	5.39%	SEU3
P1 UV Curing System	1,457,875.62	5.38%	SEU4
P3 Compressed Air System	1,379,585.09	5.09%	SEU5
P2 Forming Lines	832,488.39	3.07%	SEU6
P2 Compressed Air System	469,041.00	1,73%	SEU7
P2 Compressed Air System		**81.26%**	

81.26%

To compare the total estimated energy consumption vs. data from energy bills

Data Collection Plan

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Define & implement energy data collection plan that appropriate to

- Size
- Complexity
- Resources
- Measurement & monitoring equipment

Documentation

- ✔ Relevant variables for SEUs
- ✔ Energy consumption related to SEUs
- ✔ Operational criteria related to SEUs
- ✔ Static factor(if applicable)
- ✔ Data specified in action plan
- ✔ **Accuracy & repeatability of measuring equipment – with the formalized statement in the SOPs/WIs**

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Challenges in Data Collection

Lack of data on specific energy uses – may need to install energy sub-meters

Lack of data on relevant variables – may need to add measuring devices – e.g. sensors

Collected but incompatible data forms – e.g. energy data collected at different frequency & for different purposes

Measurement plan for data collections: Key considerations

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What is measured

- Why is it measured
- How is it measured
- How often is it measured
- What values are expected
- Who is responsible
- What is the record
- What is a significant deviation
- What actions are taken for significant deviation?

Examples: Measurement resources

SEU	EnPI	Relevant variables	Measurement resources	Preferred meter options
Compressed air system	Energy consumption/output air volume ($kWh/m^3/day$)	Compressed air flow	Electricity meter	• Spot check the flow • Continual measurement not cost effective for flow meter • Re-evaluate in three months or consider pressure as indicator
Steam	Comparison of actual vs expected using fuel consumption of boiler regressed with production and heating degree days (HDD)	Production activity and HDD • Production data • HDD data	Fuel meter	none
Building heating	Energy consumption normalized by heating degree day occupancy(Gjday)	Heat meter, Gas meter, HDD from web	Qccupancy	Get security records for improved occupancy records

Data Gathering

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Data Collection	Measurement	Data Collection Frequency	Data Quality
• Specify data • Collection at any time of the process • Specify source of energy with relevant variables • Document assumptions & method in calculations • Include static factors data • **To justify the need for budget for meters/sensors**	• Permanent/portable meters • Consider existing metering availability & capability • Take measurements of each energy value c/w relevant variable necessary to calculate selected EnPIs & corresponding EnBs	• Set the adequate frequency of each energy consumption & relevant variables • May be with higher frequency than reporting frequency-to measure & understand the impact of relevant variable on energy performance-hourly/daily/ weekly data for operational level • Consider the frequency of data needed for energy performance monitoring needs for new measurement system	• Ensure reliability & accuracy of meters • Check atypical operating conditions • Check calibration needs & keep records

Example : Data on variables & energy consumption collected, analysed & documented

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Month	Gas	Electricity	Total Energy Consumption	Energy Variable	Estimated Consumption (kWh) [y=mx+c.] Regression year – 2016 – 2017
	Yearly(kWh) 1mmbtu = 293.07kW	kWh	kWh	Total production (Tons)	
Jan-1	12,730,720	2,002,800	14,733,520	17,631	14,793,501
Feb-1	14,255,025	2,057,160	15,882,286	19,931	16,181,523
Mar-1	16,497,234	2,133,610	15,830,126	15,487	15,181,906
Apr-1	9,997,041	1,714,701	10,811,145	15,790	15,699,581
May-1	13,798,668	2,702,800	14,531,543	18,733	16,413,850
Jun-1	12,485,303	1,453,560	16,681,165	17,831	13,683,784
Jul-1	16,997,345	2,139,610	16,568,282	18,965	15,583,364
Aug-1	13,991,362	2,141,760	14,313,663	18,791	13,594,995
Sep-1	15,912,799	1,928,960	16,291,164	17,833	13,865,784
Oct-1	16,368,644	1,725,950	19,241,495	17,806	13,894,693
Nov-1	11,328,873	1,567,090	19,553,693	16,733	13,291,874
Dec-1	16,017,859	2,032,800	23,318,271	18,063	13,692,792
Jan-1	13,187,684	1,892,440	15,079,924	18,681	15,801,156

Energy consumption

Relevant variable

Examples: Data on energy consumption related to SEUs

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Asset/Code Number	Section	Year	Quaniity	Running	✓ Rated	Stand-by Voltage(V)	Rated Pow (kW)	Measured Average Amp(A)	Measured Gas Consumption (Aw)	Currently with sub-energy meter/Yeas ꞓ of installation ii Yes	Operating Hours/Day	Operating Days/Year	Consumption per year (kWh/yr)	
													Electrical	Gas
6000416003	Striko 1	1996	1	✓	415	1.8	920	1,670	529,64	No	24	24	34,211	1,012,650
	Striko 2	1996	1	✓	415	1.8	320	1,331	569,67	No	24	24	46,578	3,964,550
	Morgan	1996	1	✓	415	1.8	320	1,331	628,97	No	24	24	56,911	960,906
60004160003	Dust Collector	1996	1	✓	415	1.8	320	1,321	538,97	No	24	24	258,766	-
	Transport Ladle 1	1996	1	✓	415	1.8	320	1,331	538,67	No	24	24	258,768	-
	Transport Ladle 2	1996	1	✓	415	1.8	320	1,321	898,97	No	24	24	258,768	-
	Transport Ladle 3	1996	1	✓	415	1.8	320	1,331	838,97	No	24	24	258,736	-
6000416005	GDC line 1 & 2	1981	1	✓	415	1.8	320	1,321	888,97	No	24	24	258,796	-
	GDC line 3 & 4	1981	1	✓	415	1.8	320	1,321	898,97	No	24	24	103,291	72,221
	GDC Ventilation	1996	1	✓	415	1.8	320	1,321	838,67	No	24	24	256,311	900,690
	Oven	2005	1	✓	415	1.8	320	1,321	868,67	18,560	24	24	175,609	175,604
6000416005	PF	20C1	1	✓	415	1.8	320	1,321	888,97	No	24	24	113,502	-
	PDC 1	2003	1	✓	415	1.8	320	1,321	888,97	No	24	24	562,833	1,080,954
6000416005	PDC 2	2005	1	✓	415	1.8	320	1,321	888,97	No	24	24	279,968	-
	PDC 3	2005	1	✓	415	1.8	320	1,321	888,97	No	24	24	168,609	-
	Dust Colletor PDC 6		1	✓	415	1.8	320	1,321	868,97	18,080	24	24	562,954	252,032
	Ventilator		1	✓	415	1.8	320	1,321	888,97	No	24	24	779,423	175,071
	Evaporator	2021	1	✓	415	1.8	320	1,321	838,97	1293	24	24	29,071	120,741
			1	✓	415	1.8	320	1,321	868,97	No	24	24	30,714	-

Example : Information and data on **Operational controls criteria** related to SEUs

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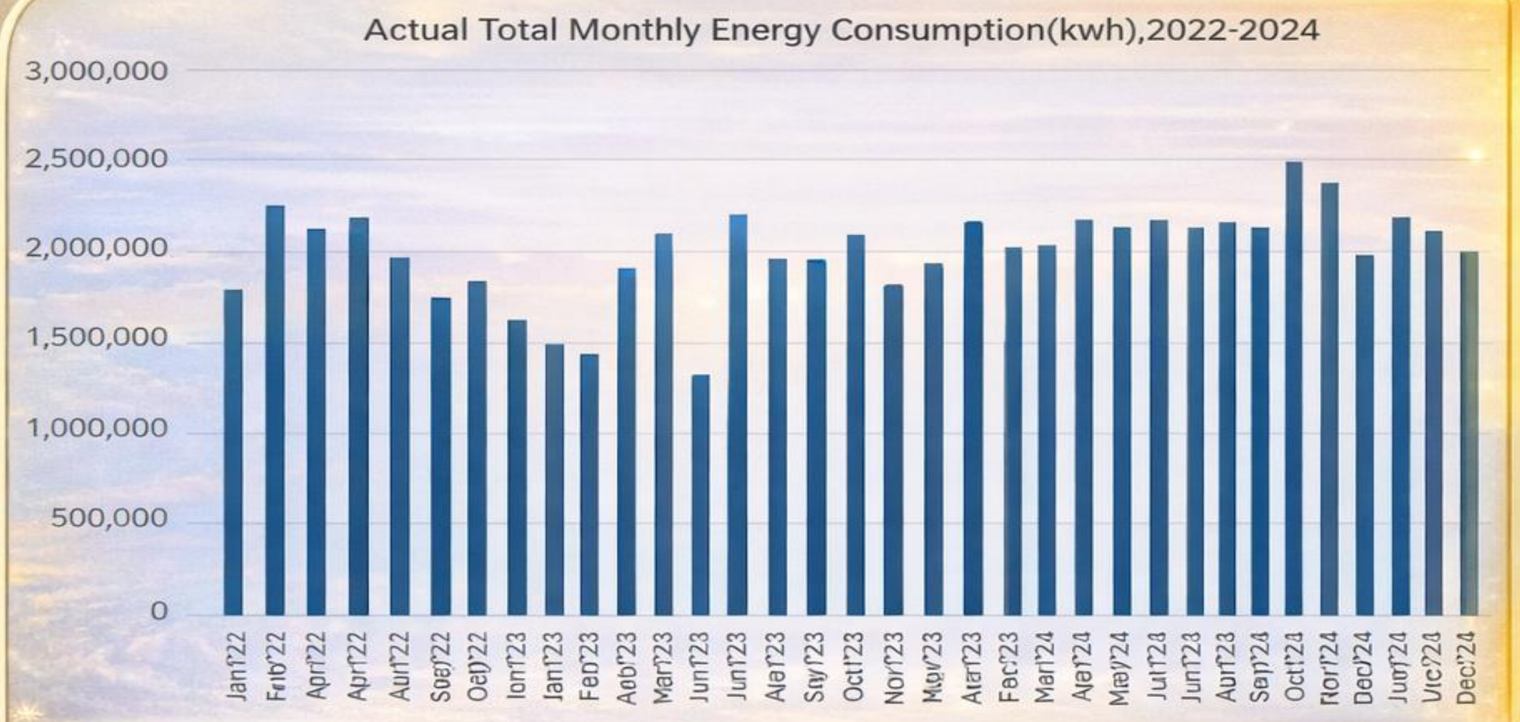
ID	Equipment(SEU)	Frequency	Operation Key parameters measured & monitored	Maintenance	Expectation
ID1	Cooling system-Chiller	Daily(Night, Morning, Afternoon)	Temperature(Celcius), Current(A)	Data logging from on-site meter	Reading values within desired range
ID2	Cooling system-Evaporator	Daily(Night, Morning, Afternoon)	Temperature, Pressure(kPa), Valve position(%)	Data logging from on-site meter	Reading values within desired range
ID3	Cooling system-Condenser	Daily(Night, Morning, Afternoon)	Temperature, Pressure(KPa), Valve position(%)	Data logging from on-site meter	Reading values within desired range
ID4	Server Room Primary Air conditioning	Daily(Night,	Pressure,Temperature	Data logging from on-site meter	Data collected accurately
ID5	Water Cooled Air coditioners	Daily	kWh per day from the sub-meter	Data logging from on-site meter	Data collected accurately
ID6	Split Units Air Conditioners	Daily	kWh per day from the sub-	Data logging from on-site meter	Data logging accually
ID7	Cooling Tower(CT) Pumps	Monthly	Cleaning and visual inspection	According to the online-accessible checklist in SAP	Cleaning, auditory and visual inspection
ID8	Air Handling Units(AHUs)	Monthly	Cleaning, auditory and visual	Cleaning, auditory and visual inspection	Clean and no physical abnormalities
ID10	Chilled Water Pumps(CHWPs)	Monthly	Cleaning, auditory and visual	Cleaning, auditory and visual	Clean and no physical abnormalities

Operational criteria

Examples of data specified in the action plan

No	Description of Energy Saving Measures	Date/Year Started	Service/ System/Type	Location / Plant	Projected Savings (kwh)		Method & Conditions of S& aisting Savings	M&1 Method (Submeter/calcuation/ combined)
					kWh	RM		
1	Replaced 1 unit old Air Cond. WCPU with new unit At Building 2 1st floor (Approved 28 Sept 2016)	2015	Cooling	B2 1st floor	419,040	155,000	24 hours 360 days	Calculation
2	Replaced old 1 unit Chiller to new chiller with inverter at building 1 (approved 29 Sept 15)	2015	Cooling	B1	518,400	157,334	24 hours 360 days	Calculation
3	Changed 18 fluorescent Car park and motorige parking areas with motlon LED tube.	2015	Lighting	Common area	4,875	1,865	24 hours 360 days	Calculation
4	Changed down Light to LED type at walk way areas.	2015	Lighting	All down light	11,700	4,095	243 days 24 hours	Calculation
5	Remained area are lighting system to LED	2015	Lighting	Remained area	92,556	29,463	365 days 24 hours	Calculation
	Sub-total			**1,036,925**	**1,048,560**	**1,048,560**	**350,668**	
9	Replaced 3 unit old old Chiller to new chiller with inverter at B1	2016	Cooling	B1	390,000	157,334	365 days 24 hours	Calculation
10	Replaced O 1 unit Air Compressor + dryer system to new unit	2016	Air Compressor	B1	439,200	157,334	365 days 24 hours	Calculation
12	Replaced O 1 unit of EmS (approved: 17	2016	B1	B1	433,620	157,334	365 days 24 hours	Calculation
				Total	**1,036,925**	**350,668**		

Analyze past & present **monthly** energy consumption trends



- What can you see & what can you explain?
- What data & information do you use from it?
- What is your expectation for next month & by year end?
- What actions have been taken & what actions will you take?
- Who can answer all the above for you?

Year	2022	2023	2024
Maximum(kWh)	2,364,178	2,282,126	2,600,396
Minimum(kWh)	1,623,128	1,380,680	2,043,277
Average(kWh)	2,000,180	1,958,269	2,325,157

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EnB & EnPI

Energy Performance Baseline & Energy Performance Indicator

Reminder when establishing EnPI and EnB : Static factors and relevant variables

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Static factor

- Identified factor that significantly impacts energy performance and does not routinely change
- Example: facility size, design capacity, etc.

Relevant variables

- Quantifiable factor that significantly impacts energy performance and routinely changes
- Example: Weather conditions, production output, etc.

Energy Efficiency/Performance Indicators (EEIs/EnPIs)

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Definitions:

EEI – a measurement that shows the efficiency of the energy used in a system, process or organization – *Guidelines on EnMS*

EnPI: Measure of unit of energy performance as defined by the organization–ISO50001:2018

Determine EnPIs that

- Are appropriate for measuring & monitoring its energy performance
- Enable the organization to demonstrate energy performance improvement.

Has data indicating that relevant variables significantly affect energy performance, the organization shall consider such data to establish the appropriate EnPI

Indicators to measure energy performance

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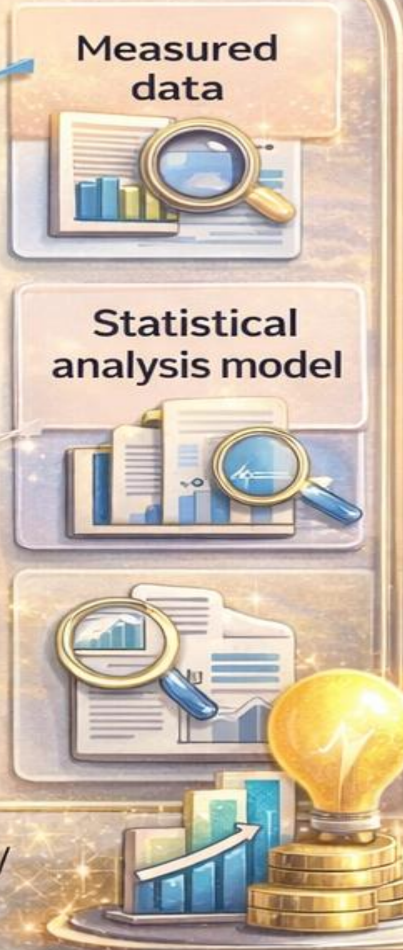
Numerical Indicators

- **Energy Performance Indicator (EnPI): unit to measure**
  - Energy Consumption (energy unit) · appii- cable for all levels of ener gy consumption
  - Index (energy unit/variable unit)
- **Energy Baseline(EnB) : EnPI value to compare**
  - Energy Consumption (energy unit)
  - Index value (energy unit/variable unit)
  - Efficiency value (System or equipment)



⚠ **The use of energy consumption** as the indicator need to consider the same static factors/ operating conditions - Quantifying energy consumption is essential for measuring energy performance and energy performance improvements.

☑ **The use of index** as the indicator need to be confirmed with suitable methods such as Regression Analysis with sufficient data available

Define EnPI scope & boundaries

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Organization

- **Around physical parameter of a group of facilities/ process/equipment**
  Take into account the **responsibility i**n energy management of individuals, teams, groups or designated business unit
- **Steam purchased by** the organization Around physical parameter of a facility/equipment/process to **be controlled & improved**

System

- **Around physical parameter of a group of facilities/equipment/process to be controlled & improve**
- e.g. steam production & steam use equipment - dryer

Individual facility/ equipment

- **Around physical parameter** of a facility/equipment/process to be controlled & improve
- e.g. Steam production equipment

Example of EnPIs

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Gross production related – Must be tested & confirmed!

- kWh/MT clinker or cement produced-Cement plant
- kWh/kg yarn produced-Textile unit
- e.g. kWh/MT, kCal/kg, paper produced-Paper plant
- kCal/kWh Power produced - Heat rate a power plant
- Million kilocals/MT Urea or Ammonia - Fertilizer plant
- **kWh/MT of liquid metal output** - Foundry

Equipment / utility related – From best practices/standards

- **kW/ton of refrigeration** - Air conditioning plant
- % **thermal efficiency** - Boiler plant
- % **cooling tower** effectiveness – Cooling Tower
- (kW/m3 per min) - Air Compressors

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Energy Baseline (EnB)

Definition – Quantitative reference(s) providing a basis for comparison of energy performance (ISO50001:2018)

Establish the EnB using the information from the data analysis & taking into account a suitable baseline period

Has data indicating that variables significantly affect energy peformance, the organization shall carry out normalization of the EnPI value & corresponding the EnB

Data to consider relevant variables that affect energy performance significantly for EnPI value normalization & corresponding EnB

To be revised when:

- The EnPI no longer relevant
- Major changes to the static factors
- According to pre-determined method

✓ **Quantification of success** (or failure!)

EnB Based on Historical Energy Consumption

· Characteristics ·

Answers the question: "How much would I have used in absence of my energy-saving measures?"

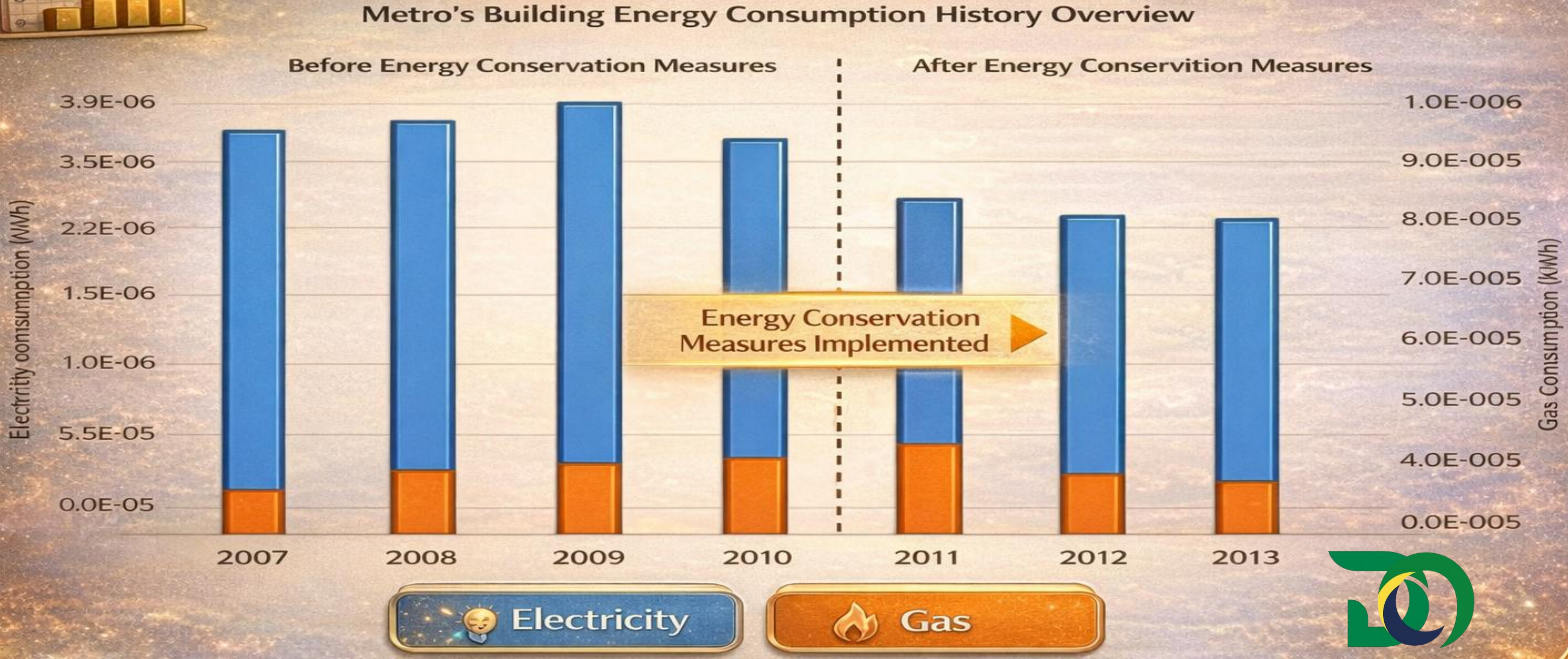
Allows absolute energy consumption reduction unit savings to be computed

- Gives clean, objective view
- Production, weather, etc. already accounted for

Must confirm the restrictions(static factors) for its validity

EnB Example: Comparison of Historical Energy Consumption

• Energy Bills •



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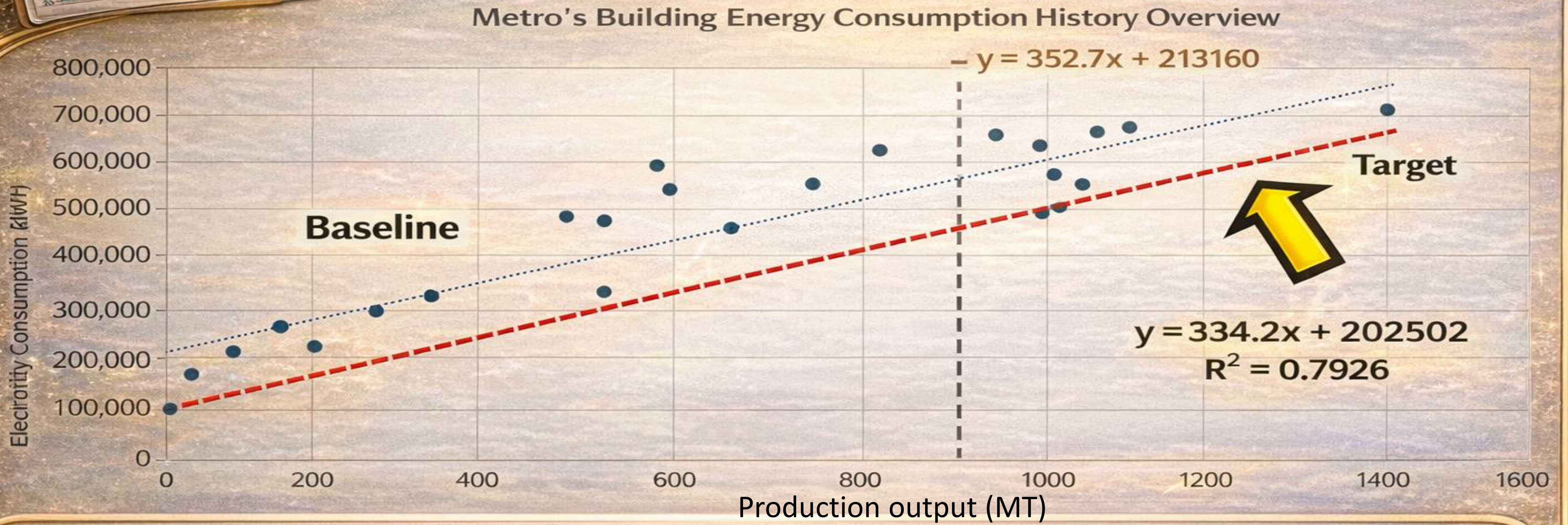
Example: Baseline & Targets from the Result of Single-Variate Regression Analysis



- Alter the formula to reduce by targeted amount
- Example: multiply coefficients by 0.95 (5% energy consumption reduction target)

When Should R^2 Be Close to 1?

What is R^2?

R^2 *measures how well your regression* ***model explains*** *the variability of the data*

R^2 Interpretation

$R^2 < 0$	*Worse than Mean*	$R^2 = 0$	$R^2 \geq 0.75$ *Good Model*	$R^2 \geq 0.85$ *Very Good*

$R^2 = 1$ Perfect Fit

When Should R^2 Be Close to 1?

- ✔ *Accurate Prediction*
- ✔ *Well-Controlled / Deterministic System*
- ✔ *Building Energy Baseline (EnB) Models*

Example: *Energy Consumption vs.* ***Production*** *in a Stable Plant (ISO 50001)*

- *Higher Production → Higher Energy Use*
- *High R^2 Expected* ✔

⚠ ***Don't Chase R^2 = 1 Blindly***

Focus on ***Realistic & Useful Models***

Energy Modeling Benchmarks:

- ✔ $R^2 \geq 0.75$ *Good Model*
- ✔ $R^2 \geq 0.85$ *Very Good Model*

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Baseline from Regression Analysis

Forecasted vs Actual Monthly Energy Consumption

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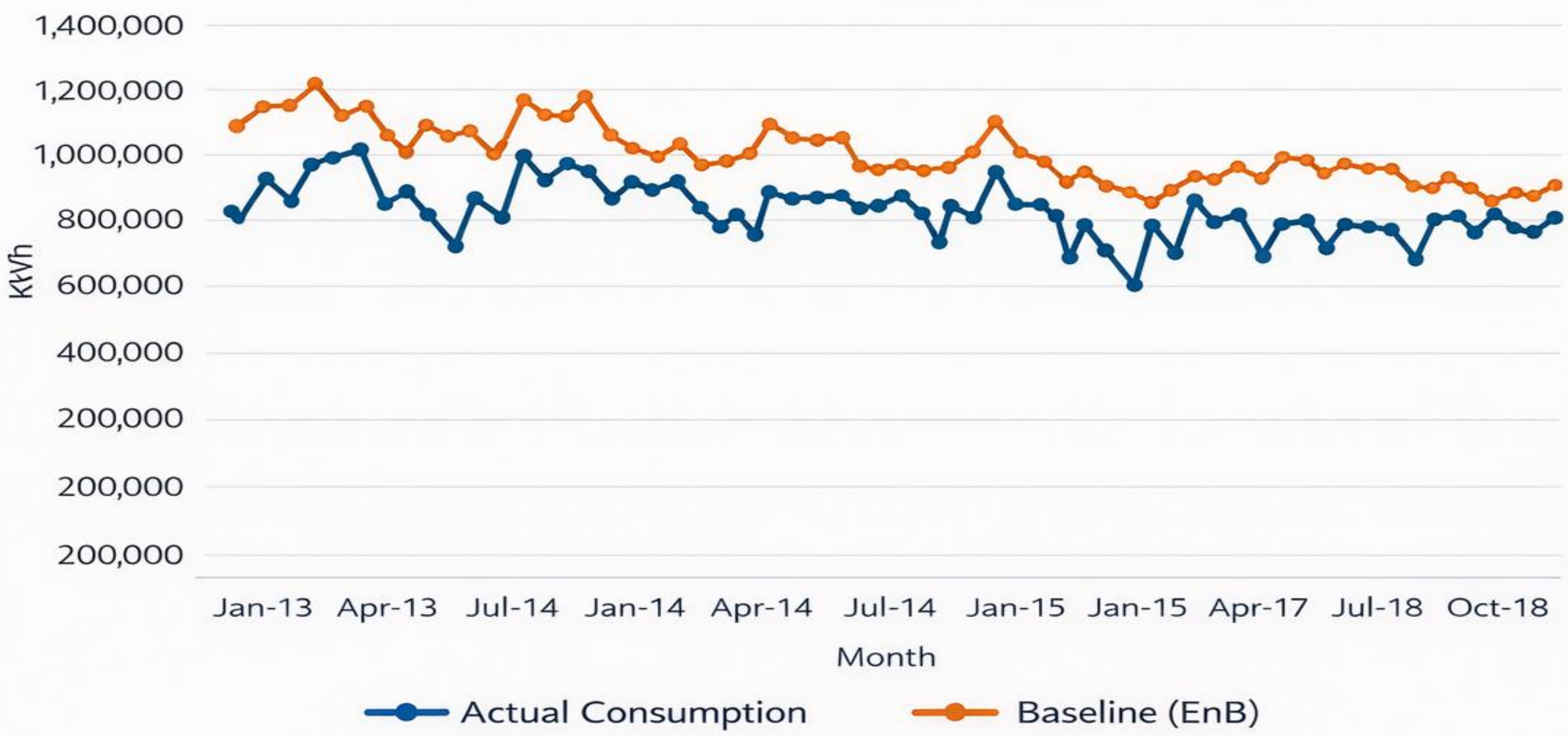
Forecasted vs Actual Monthly Energy Consumption



✔ If Actual < Baseline — Energy Saving | ⚠ If Actual > Baseline

Key Insights

- Baseline derived using regression model
- Actual consumption fluctuates due to operational variation
- Gap indicates energy performance deviation

Interpretation

✔ If Actual < Baseline — Energy Saving

⚠ If Actual > Baseline — Improvement Needed

Benchmarking Based on Industry Type

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Sectors	Units	Developed Countries	Developing Countries	Global Average	Lowest Found	BAT
Petroleum refineries	EEI	0.7 – 0.8	1.3 – 3.8	1.25	1.0	1.0
High value chemicals	GJ/t	12.6 – 18.3	17.1 – 18.3	16.9	12.5	1.5
Ammonia	GJ/t	33.2 – 36.2	35.9 – 46.5	41.0	31.5	23.5
Methanol	GJ/t	9.3 – 10.9	33.9 – 40.2	35.1	26.0	28.5
Alumina production	GJ/t	10.9 – 15.5	10.5 – 24.5	16.0	7.8	7.4
Aluminium smelting	MWh/t	14.8 – 15.8	15.5 – 15.0	15.5	14.2	1.8
Copper	GJ/t	–	–	13.8	7.4	6.3
Zinc	GJ/t	15.9 – 19.7	16.7 – 22.7	23.6	15.2	102
Iron and steel	GJ/t	15.2 – 19.7	16.7 – 22.7	23.6	15.2	–
Clinker	GJ/t	3.3 – 10.9	35.2-46.5	41.1	31.5	23.5
Cement	kWh/t	109 – 15.5	10.5 – 24.5	16.0	7.8	7.4
Lime	GJ/t	3.6 – 13.0	5.0 – 13.0	5.5	3.2	–
Brick making	MJ/kg	1.1 – 3.0	1.4 – 2.2	6.5	3.0	4.2
Tiles	GJ/t	3.1 – 1.1	3.1 – 6.3	–	1.9	–
Sanitaryware	GJ/t	4.4 – 11.3	4.4 – 20.0	–	4.2	–
Textile spinning	GJ/t	3.5 – 3.6	3.5 – 3.6	1.3	–	–
Textile weaving	GJ/t	11.0 – 65.0	5.0 – 43.0	–	3.4	–
Brewery	GJ/t	–	–	229	156	1.0
Cheese	GJ/t	4.3 – 35.2	–	–	1.8	–
Fluid milk	GJ/t	3.1 – 6.5	–	–	1.0	–

Source: UNIDO, 2010

EnPI, Benchmarking and Rating for Building in EECA 2024

The BEI office building shall be expressed in energy units in gigajoule (GJ) per square meter (GJ/m2)

$$BEI\ of\ office\ building = \frac{Energy\ Consumption\ (GJ)}{\mathrm{GFA}\ (m^2)}$$

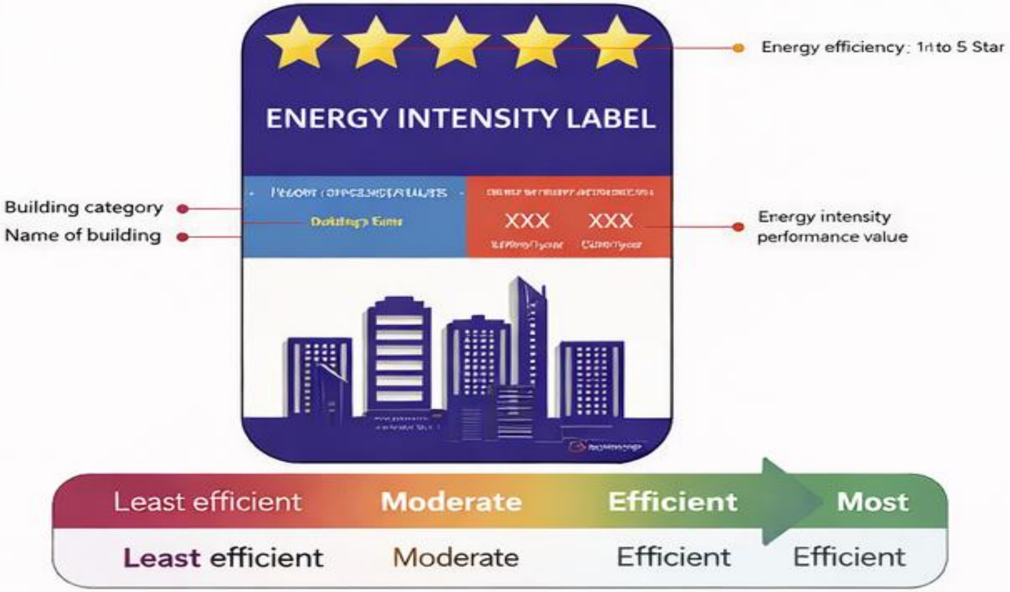

Figure: Energy intensity label for building.

The EER for an office building

Star Rating	EIP Range ($GJ/m^2/year$)	EIP Range ($kWh/m^2/year$) 1 GJ = 277.778 kWh	Indication
5-Star	EIP ≤ 0.324	≤ ≤ 90	Very efficient
4-Star	0.324 < EIP ≤ 0.396	90 < EIP ≤ 110	Efficient
3-Star	0.396 < EIP ≤ 0.576	110 < EIP ≤ 160	Moderate efficient
2-Star	0.576 < EIP ≤ 0.720	160 < EIP ≤ 200	Slightly efficient
1-Star	EIP > 0.720	EIP > 200	Least efficient

The EER for an office building with chilled water supply

Star Rating	EIP Range ($GJ/m^2/year$)	EIP Range ($kWh/m^2/year$) 1 GJ = 277.778 kWh	Indication
5-Star	EIP ≤ 0.684	≤ ≤ 190	Very efficient
4-Star	0.684 < EIP ≤ 0.864	190 < EIP ≤ 240	Efficient
3-Star	0.864 < EIP ≤ 1.224	240 < EIP ≤ 340	Moderate efficient
2-Star	1.224 < EIP ≤ 1.512	340 < EIP ≤ 420	Slightly efficient
1-Star	EIP > 1.512	EIP > 420	Least efficient

Figure. Energy intensity label for building.

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ASHRAE – CHILLER PLANT EFFICIENCY

BENCHMARKING GUIDE

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WHAT IT MEANS:
This benchmark helps evaluate chiller plant efficiency.
Lower kW/Ton (higher COP) = better efficiency.

	EXCELLENT Top Performance	**GOOD** Efficient Operation	**FAIR** Typical / Average	**NEEDS IMPROVEMENT** Action Recommended
Scale: kW/Ton (COP)	0.5 (7.0), 0.6 (6.0)	0.7 (5.0), 0.8 (4.0)	0.9 (3.9), 1.0 (3.5)	1.1 (3.2), 1.2 (2.9)
kW/Ton Range	≤ 0.6	0.6 – 0.8	0.8 – 1.0	> 1.0
COP (Equivalent)	≥ 6.0 (Higher is Better)	5.0 – 4.0	3.9 – 3.5	< 3.5 (Lower is Poor)

ANNUAL AVERAGE CHILLER PLANT EFFICIENCY: kW/Ton (COP)

HIGHER COP
= LOWER kW/Ton
= BETTER EFFICIENCY

TARGET:
≤ 0.8 kW/Ton

MONITOR:
Track & Optimize Regularly

GOAL:
Maximize Efficiency
Minimize Energy Use

Determine Opportunities and Establish Targets

(ISO 50001:2018 – Clause 6.2)

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Organizations shall use the **EnMS assessment and energy performance analysis** to identify opportunities for improvement and establish energy performance targets.

Targets shall be set, monitored, and achieved within a defined period (**typically within 3 years** from the date of establishment).

Example: 5% Energy Reduction Target

Objective	Baseline Values (2024) Based on Established EnPIs			Target Values (2025) (5% Reduction from Baseline)			
Indicator	**2024 (Baseline)**	**EnPI**	**2024 (Baseline)**	**2025 (Target)**	**EnPI**	**Absolute Reduction**	**Improvement (%)**
Energy Consumption (kWh/year)	23,499,232	0.61 kWh/pcs	22,326,866	22,326,866	0.58 kWh/pcs	1,172,366 kWh	5.00%
Energy Consumption (GJ/year)	84,321	84,321 GJ/year	80,105	80,105	4,216 GJ/year	4,216 GJ	5.00%
Production (pcs/year)	38,522,951	1 pcs	38,522,951	38,522,951	1 pcs	—	—

Timeline
Target to be achieved within **3 years** from the date of establishment.

Basis
Targets established using EnMS assessment, energy review, and EnPI evaluation.

Purpose
Drives continual improvement and better energy performance.

Framework for Setting the Comprehensive EnMS Objectives & Targets

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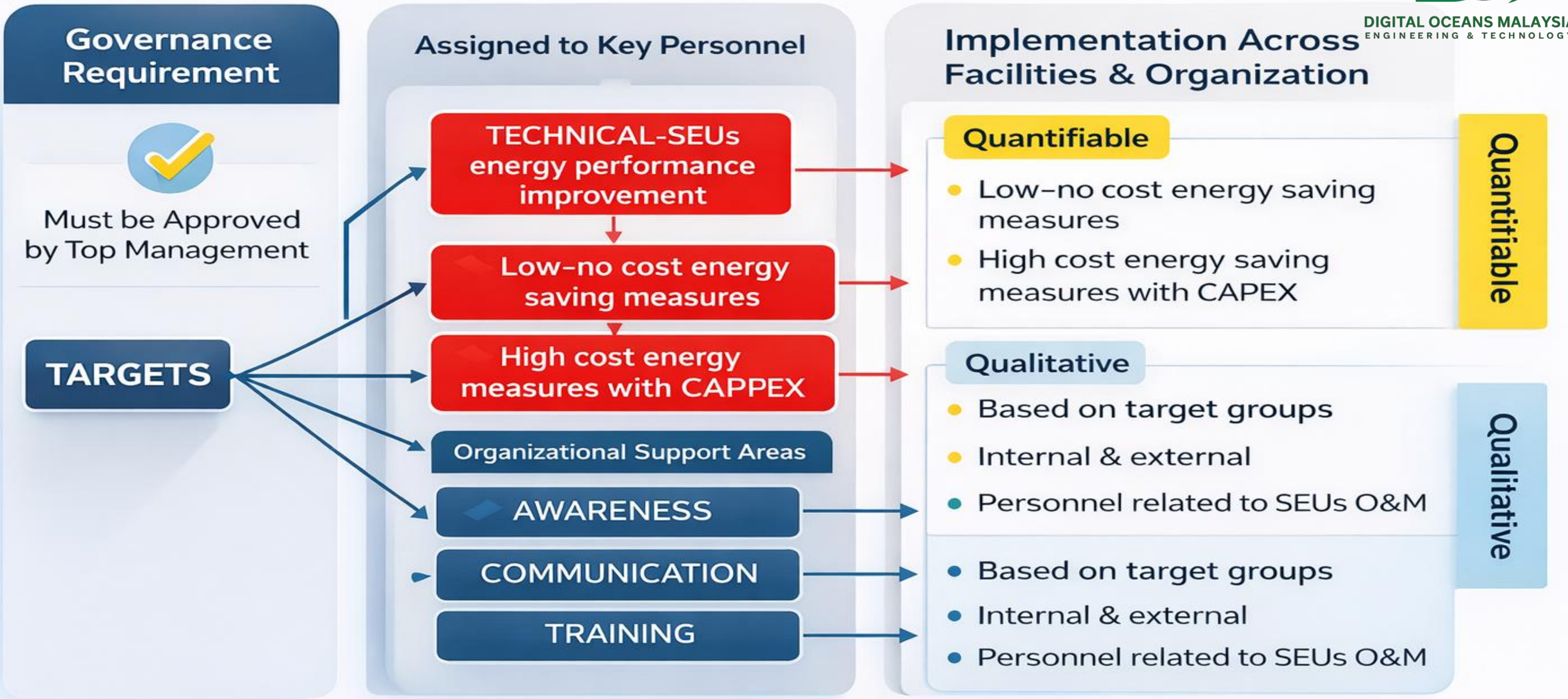

Example: Energy saving measures to achieve the target

No	Description of Energy Saving Measures	Date/Year Started	Service/ System Type	Cost Incurred (RM)	Projected Savings/year		Method & conditions of estimating savings	M&V Method (Submeter/ calculation/ combined)	PIC
					KWh	RM			
2022									
1	Admin building FCU timer project	2022	Air-conditioning system	NIL	264,212	74,243	Calculation	Submeter & calculation	Halim
Sub-Total					264,212	74,243			
2	Glycol system optimization project	2023	Ethylene glycol system	NIL	2,053,578	577,055	Calculation	Submeter & calculation	Rahman
3	Admin building lighting timer project	2024	Lighting system	TBA			Calculation	Submeter &	Chong Pin
4	CDA Air Leak Audit	2024	Compressed air system	TBA				calculation	Sim
Sub-Total					2,053,578	577,055			
Total		2022	–		2,053,578	577,055			TBA
Sub-Total		2022	–		2,053,578	577,055			TBA
Total		2022	–		2,582,001	725,542			TBA

...from identified & planned energy saving measures

Statement of Objective: To improve energy performance and consistently maintain the good practice of energy usage of the plant

Baseline year: 2022

Target: Operate in best and optimized energy consumption to meet global GHG emission target

Year	Baseline Value (Based on Confirmed EnPIs)		Saving Target (From Proposed Energy Saving Measures / ESMs)	Actual Performance Achieved (Actual Energy Consumption)		Reduce / Increase (%)	
	Energy Consumption (kWh)	Energy consumption (kWh)	Energy consumption (kWh Percentage (% - kWh)	Energy Consumption (kWh)	Saving (kWh/year)	Index (kWh/Total Production Output)	Yes
2022	131,017,943	0.201	264,212	131,017,943	270,589.10	0.201	Yes
2023	131,017,943	0.201	2,053,578	-	-	-	

From **approvevd eredg saving saming implementation by the top management**

- Baseline Value (Based on Confirmed EnP1s)
- Saving Target (From Proposed Energy Saving Measures / ESMs)
- Actual Performance Achieved (ESMs)
- Target Achieved (Yes / No) with remarks

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Case Study: Chiller Plant Optimization in Manufacturing Facility

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Factory Overview

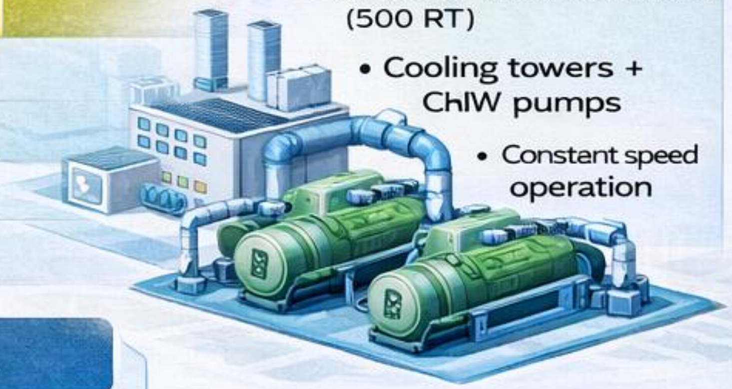
- Industry: Food & Beverage Manufacturing
- Location: Malaysia
- Operating Hours: 24/7
- Major Energy User (SEU): **Chiller Plant** (Cooling System)

Baseline Data & Findings (Before Improvement)

Parameter	Value
Annual Energy Consumption	3,600,000 kWh
Cooling Load	4,500,000 RT-hr
Operating Hours	8,760 hours
Average Efficiency	0.80 kW/RT

Chiller Plant System (SEU)

- 2+ Water-cooled chillers (500 RT)
- Cooling towers + ChlW pumps
- Constant speed operation



Key Issues Identified

- **Overcapacity → chillers** not optimized
- **No control strategy** (manual operation)
- **High auxiliary energy** (pumps + fans)

Enelgy Saving – 20%
720,000 kWh/year

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Improvement Measures Implemented

Measure	Description	Expected Saving	New Measures
Chiller loading	Run 1 chiller at optimal load	8%	↓ 8%
VSD for pumps	Install VSD to adjust pump speed	10%	↓ 10%
Cooling tower	Adjust fan speed based on ΔCT	5%	Energy <ΔT
Monitoring	Implement real-time energy	—	Improved EnPI & visibilty

Total Estimated Saving → 20%

Delta (difference in T in and T out)
T_in = Hot water temperature entering cooling tower
T_out = Cold water temperature leaving cooling tower

ISO 50001 Learnings | Before → After

Energy (kWh) →	3,600,000 - 2,880,000	↓ RM 360,000/year
EnP1 (kW/RT) →	0.80 → 0.64 KW/RT	↓ Improved

Key Learning Points for Participants

- Focus on **SEUs** (like chiller):. ✔ Use EnP1 (kW/RT) for tracking
- Combine technical + operational improvements → Even simple inpovements

Action Plan Development

Functions and Duties of REM

To advise energy consumer on energy saving measures which may be implemented and monitor their implementation

Advise consumer on **energy saving measures**, and monitor their implementation

- Refer to identified energy saving measures, in the **energy audit report**

- Refer to identified energy saving measures in the energy audit report
- Propose an action plan to EMC based on the audit report
- Propose Measurement & Verification (M&V) plan to EMC

...from identified & planned energy saving measures

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Establish Strategies

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The committee shall

Review EnMS self-evaluation & assessment findings, technical assessments & energy audit findings

→

Define technical strategies for improving the current performance to achieve the targets

- implementing ESMs, developing SOPs & guidelines

→

Determine other capacity development programs

- training, awareness, campaigns & sharing best practices.

EECA 2024 : Energy Audit Report

Inputs during the EnMS development and for continual improvement-identified and quantified energy performance **improvement** opportunities/ESMs

Inputs during the EnMS development and for continual improvement-identified and quantified energy performance improvement opportunities/ESMs

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Determine & Prioritize Opportunities for Improving Energy Performance (Energy saving measures)

- A formal **energy audit** can be used to assist in identifying opportunities for energy performance improvement in detail. An energy audit can provide information on one or more parts of the energy **review**

- Can comprise a detailed review of the energy performance of SEUs, systems, energy-using processes & equipment
- Based on appropriate measurement & observation of actual energy performance
- Include information on current **consumption** & energy performance
- Specific recommendations ranked by energy performance improvement or financial return on investment, based on a analysis of specific site data & operating conditions
- Consider energy recovery

Opportunities

- Can also emerge over time due to changes in operating loads & parameters, equipment degradation & improvement in available technologies & techniques.
- How equipment & systems are operated & maintained.

Opportunities

- Where appropriate, a energy review can also consider security & availability of energy supply

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Energy Savings Measures

Example : Determined current energy performance for equipment

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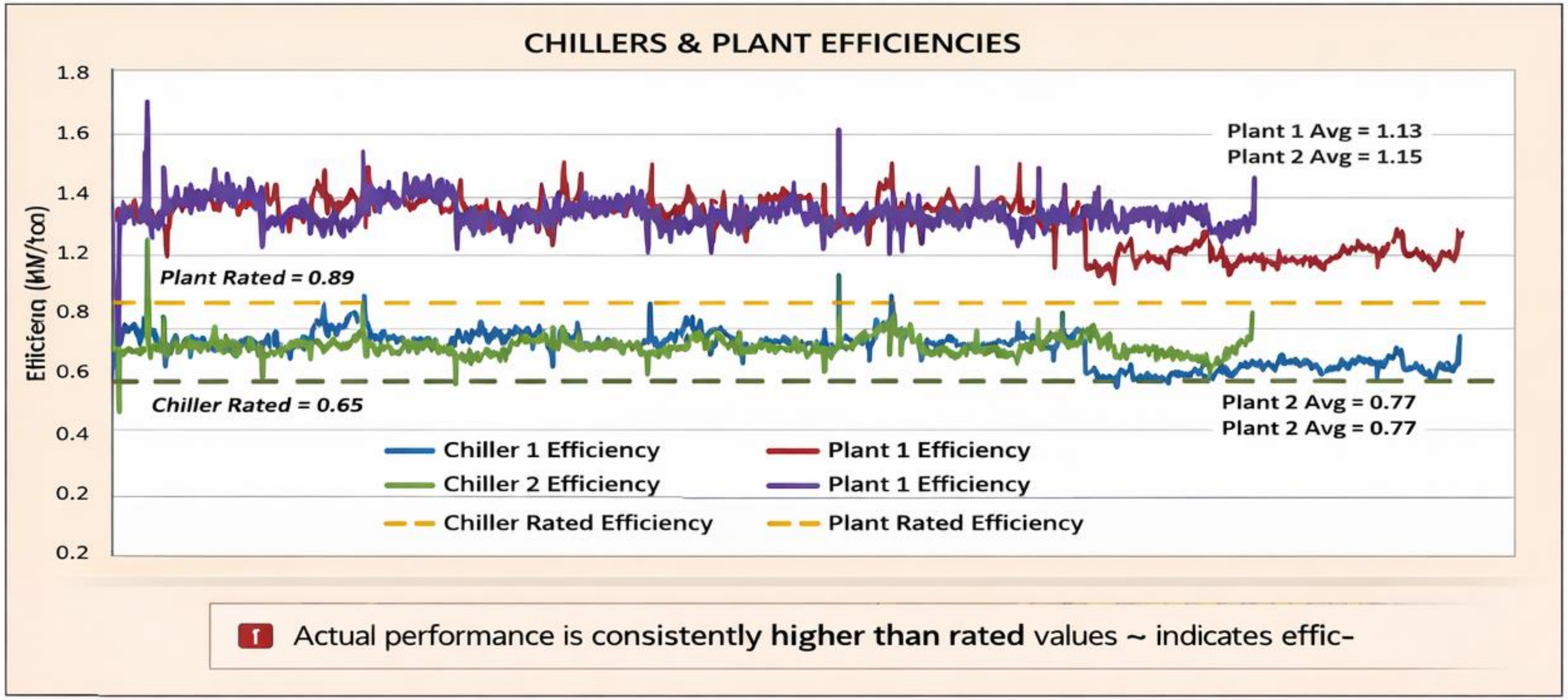

Chillers and Plant Efficiencies Summary

	Chiller 1	Chiller 2	Plant 1	Plant 2
Efficiency, Rated (kW/ton)	0.65	0.65	0.89	
Efficiency, Actual Average (kW/ton)	0.76	0.77	1.13	
Difference (kW/ton)	0.11	0.12	0.24	
Difference (%)	17%	18%	30%	

Chillers and Plant Efficiencies Summary

Chiller Plant Performance Summary

Item	Plant 1	Plant 2
CHW Flowrate (m³//day)	11,086	10,523
CHW Temperature Difference (°C)	3.30	3.35
Total Cooling Load (ton)	4,409,455	4,255,714
Efficiency (kW/ton)	1.13	1.15
Power consumption (kWh/year) 1) Actual 2) Rated	 4,982,323 3,924,415	 4,909,434 3,787,585

Source: MAREMA

Energy Savings Potentials from Motors

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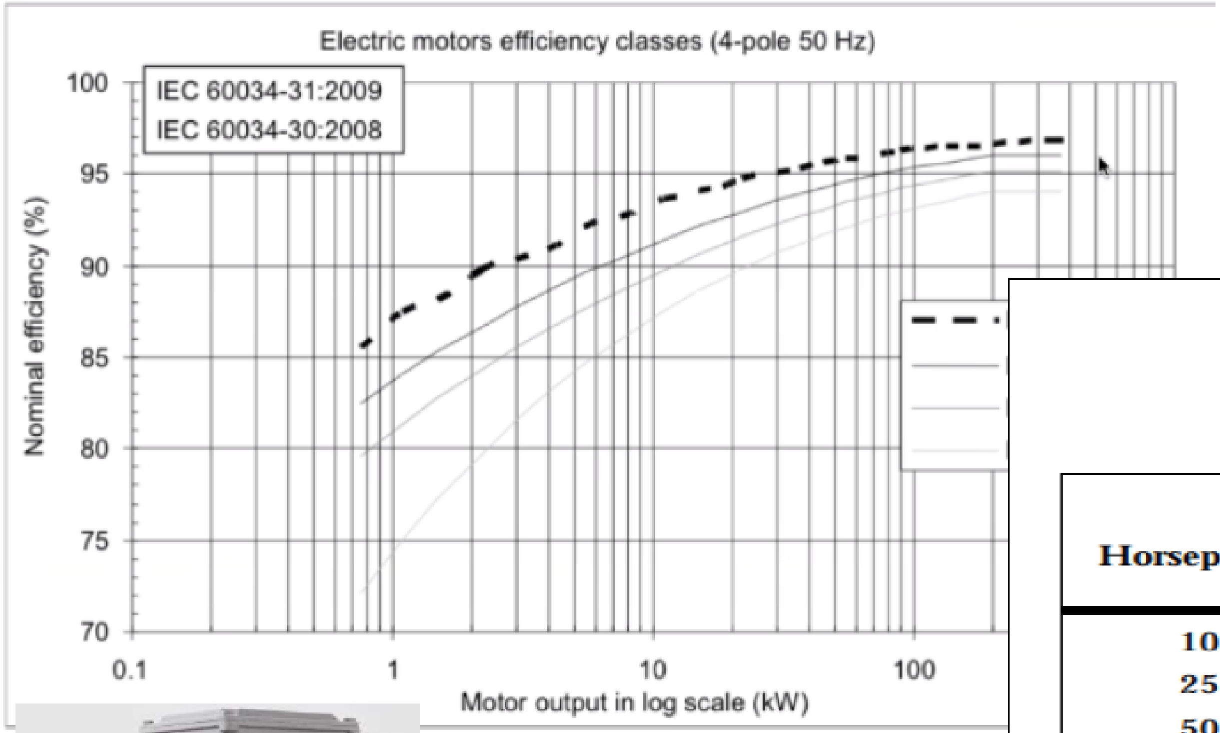
Comparison between standard and efficiency motors



- Operational control
- Proper Sizing of motors
- Hight efficiency motors
- The application of variable speed drives(VSDs)
- Motor alignment

EE vs. NEMA Premium Efficiency Motor*

	Full Load Efficiency %			Annual Savings from Use of a NEMA Premium Motor	
Horsepower	Energy Efficient Motor	Premium Efficiency Motor	Relative Energy Saving	Annual Energy Savings kWh	Dollar Saving $/year
10	89.5	91.7	2.2	1200	60
25	92.4	93.6	1.2	1553	78
50	93.0	94.5	1.5	3820	191
100	94.5	95.4	0.9	4470	223
200	95.0	96.2	1.2	11,755	588

* Based on purchase of an 1800 RPM TEFC Motor with 8000 hr/year operation at 75% load at $0.05/kWh – source Motor Systems Tip Sheet #1 • September 2005 – US DOE Publication (Ref. 22).

A Case Study in Malaysia

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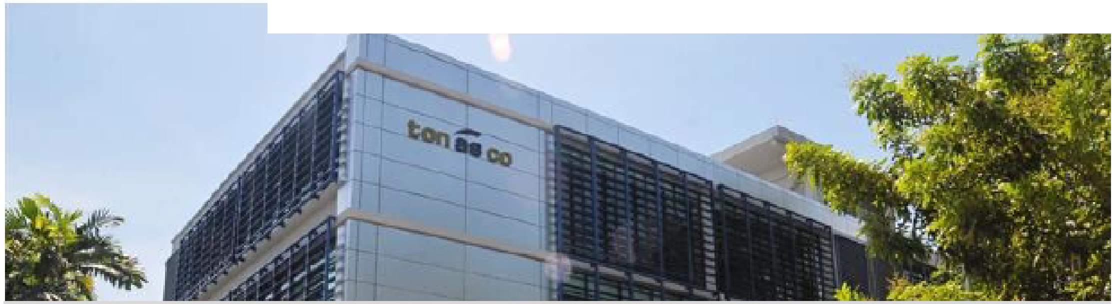
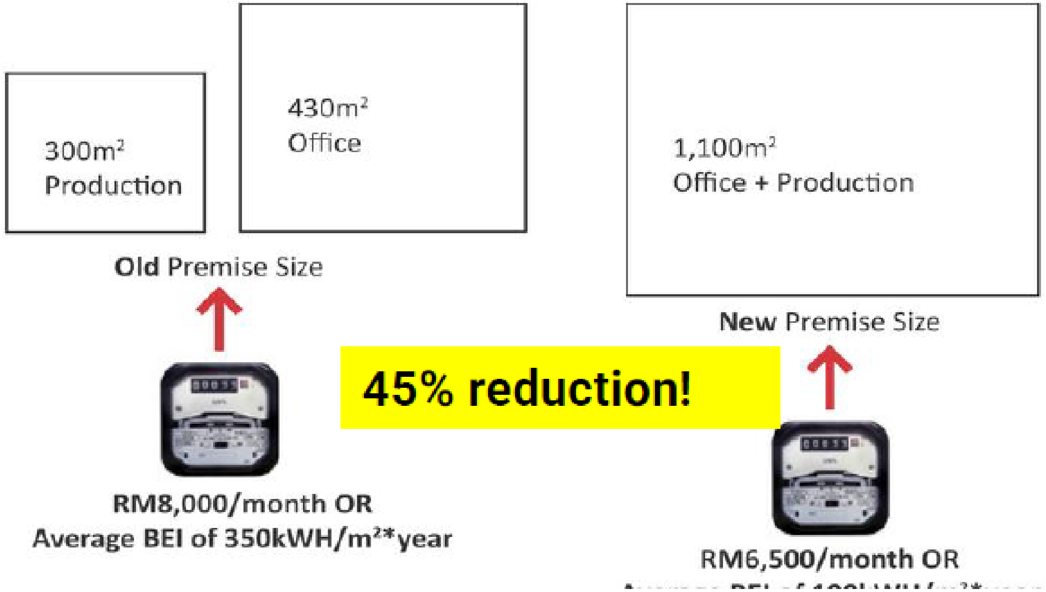
Source: MAREMA

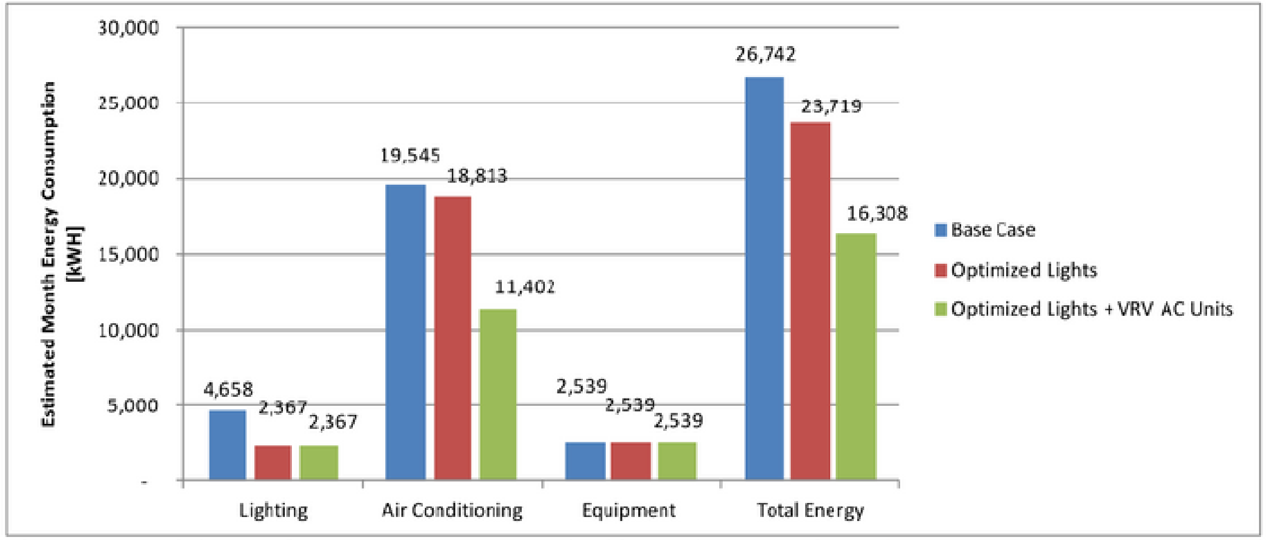
Small Industrial Premise Fit-out: Surpassing Energy Efficiency Goals



Moved the operations (Office & Production) to a new premise which would be 30% larger (by Gross Floor Area) but kept the energy bills the same or lower than the previous energy bill



45% reduction!



- Breakdown of Energy Consumption (Calibrated IES Simulation)

Solutions implemented

- **Electric lighting design**
- **Removed existing dark tint of the external glazing to allow better daylight penetration and improved view-out**
- **Energy efficient air conditioning system**

Source : IEN Consultants at ien.com.my

Roles and Resources

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Identify the individuals involved in each ESM in the action plan & define their ownership & responsibilities

Estimate the cost & human resources required for each ESM in the action plan

Funding Options for Energy Saving Projects Implementation

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INTERNAL

- Conventional Procurement

EXTERNAL

- Loan
- Grants

External & By Third Parties

- Energy Performance Contracting – Shared Saving Model
- Energy Performance Contracting – Performance Guarantee Model
- Leasing

Investments in energy saving projects implementation require the financial evaluation to confirm its financial feasibility for decision-making by the top management

Common Methods Used To Evaluate The Financial Feasibility of Investments for Energy Saving Projects

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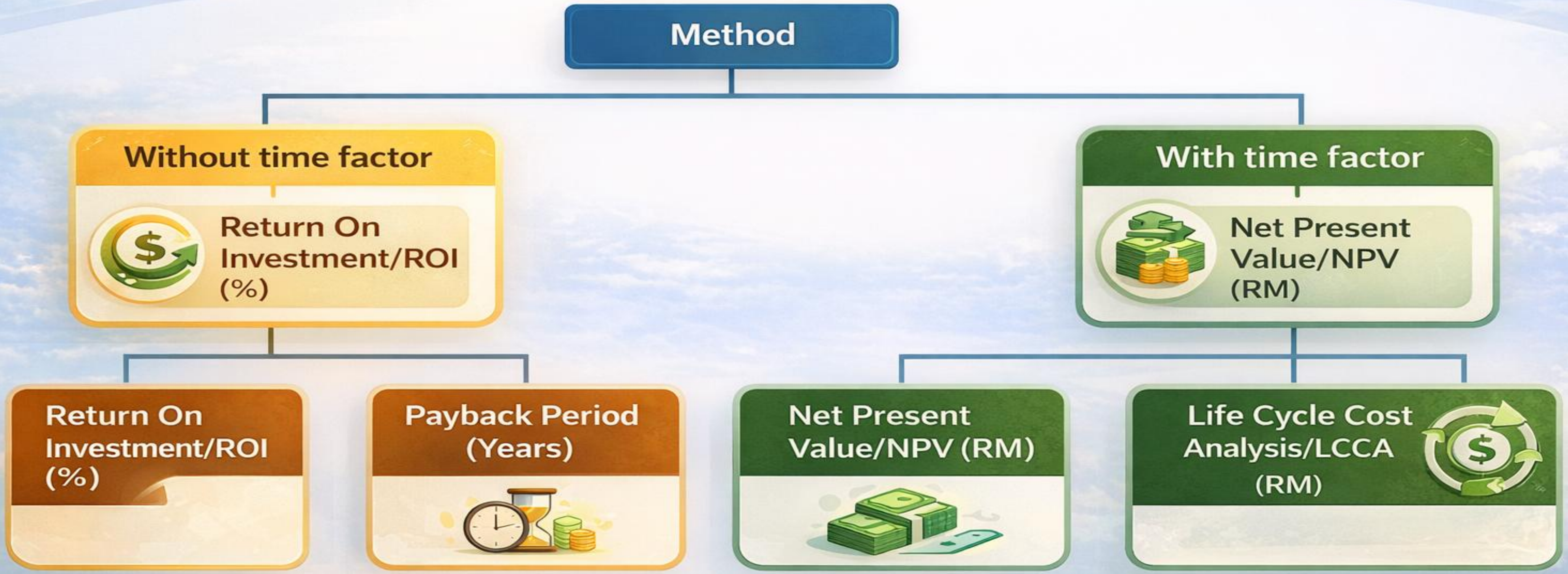

Follow the financial procedures and methods used by the organization for decision making in financial investments.

Example : The action plan with estimated energy savings and cost incurred for the implementation of each ESM

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No	Description of Energy Saving Measures	Date/Year Started	Service/System/Type	SEUs (Major/Minor)	Location / Plant	Cost Incurred (RM)	Simple Payback Period (year)	Projected Savings/year		
								GJ	kWh	RM
1	P1 L2, L3, L6 Temperature Reduction during Complete Changeover, Smart Burner	1/1/2025	Drying Oven System	Major	Plant 1	15,000	1.3	219	819	60,803
2	P1 L3 Installation of Heat Recovery System	1/1/2025	Drying Oven System	Major	Plant 1	100,000	1.4	1,313	36,487	69,351
3	P1 L9 Upgrade to LED Curing System	1/1/2025	UV Curing System	Major	Plant 1	2,0008	6.2	1,556	542,583	322,019
4	P1 Ar Leekage Mobilication/ Efficiency using Compressed Air Systems, and Upgrade EV	1/1/2025	Compressed Printing & Coating Lines	Major	Plant 1	87,100	1.3	147	40,961	19,679
5	P1 Air Leakage Management Program	1/1/2025	Compressed Air System	Major	Plant 1	55,000	1.4	270	33,355	19,767
6	P1 Installation of Intelligent Flow Controller	1/1/2025	Compressed Air System	Major	Plant 1	55,000	1.5	270	75,100	47,006
7	P1 Install Motorized Ring, Add Solenoid Valve to Blower at Feeder	1/1/2025	Compressed Air System	Major	Plant 1	10,000	1.5	40	11,718	8,560
8	P1 L8 and L9 Control Based on Production Activity	1/1/2025	Compressed Air System	Major	Plant 1	10,000	1.2	28	7,852	4,633
9	P1 Installation of Demand Control Device (DCD) at LB	1/1/2025	Centralized Air System System	N/A	Plant 1	10,000	1.5	85	23,557	33,883
10	P1 Installation of Denand Control System (DCS) Multi-Stage Conderssation Tech	1/1/2025	Split Unit Egg Lines	N/A	Plant 1	10,000	1.8	36	9,878	13,839
11	P1 Motor Energy	1/1/2025	8 Color Printing Lines	N/A	Plant 1	10,000	1.8	28	7,552	16,339
						Total	**4,234**	**1,254**	**1,176,187**	**523,702**

Example: The action plan to achieve EnMS objectives and targets with the targeted completion period, status & responsible personnel

No.	Activity/Project	Date / Year Started	Targeted date/month	PIC	Remarks
1	Lighting Conversion to LED	2022	2024	Project Team	ESM
2	Advanced Training on Energy Management System Development and Implementation Based on ISO 50001:2018 For Certification	2023	12-13 Sept 2023	Completed	HR Training/Awareness
3	ISO50001 EnMS Management Awareness Briefing	2024	6 Feb 2024	Completed	Training/Awareness
4	ISO50001 EnMS Awareness Briefing	2024	7-8 March 2024	Completed	Training/Awareness
5	Training for Internal Auditors based on ISO50001 Requirements for Certification	2024	2026	Approved	Project Team
6	CCM to High-Speed Rolling Mill Plant Upgrade	2024	2026	Approved	Project Team
7	Scrap Conveyor Continuous Process for IF2	2025	2026	Approved	Project Team
8	VSD on Auxiliary Pumps (10 Units 1003-1063)	2025	2026	Approved	Project Team
9	Air Compressor Plant Upgrade (Rolling Mill)	2025	2026	Approved	Project Team
10	Upgrade ACSU to Inverter ACSU (4/5 Star)	2025	2026	Approved	Project Team
11	VSD on Centrifugal Pump	2027	2028	Approved	Project Team
12	VSD on Cooling Tower Fans	2028	2028	Approved	Project Team
				Total | 4,234	1,176,187 | 523,702

Determine current energy performance & energy saving measures to improve energy performance – common options

Walk-through assessment & observations

Regular operational & maintenance checking

Internal

Equipment / System assessment

Internal/external parties

Internal/external parties

Energy Audit

Often external parties

EECA 2024

8. (1) An energy consumer to whom this Act applies shall from time to time cause to be conducted an energy audit in respect of his activity, business or trade so as to comply with the requirirements relating to the submission of energy audit report under subsection 9(2).

Implement Action Plan

Implement Action Plan (1/2)

7.2 The progress and results shall be documented

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7.1 Implement An Action Plan

- communication
- awareness
- capacity building
- motivation strategy
- implementing control operation
- M&V

7.3 Implementation of ESM

- Energy efficiency retrofit
- Implementation of control operation

7.4 Maintenance program

- maintenance schedule into the energy monitoring work procedures
- ensure calibration of measuring equipment

7.5 Implementation of the work procedures

- handling non-conformance initiating corrective & preventive actions to minimize energy waste

7.1 Implement An Action Plan

7.5 Maintenance program

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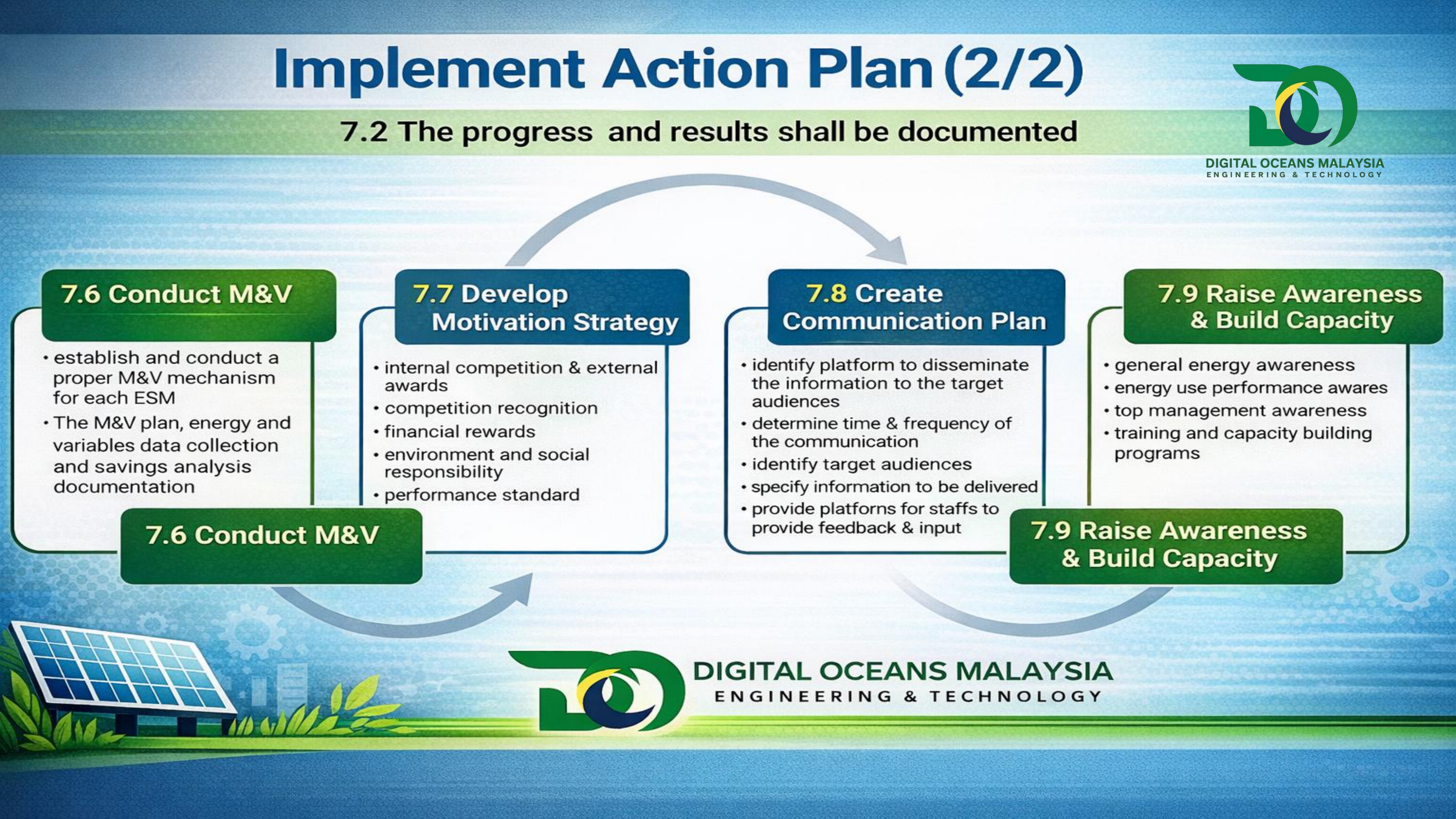
Implement Action Plan (2/2)
7.2 The progress and results shall be documented
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7.6 Conduct M&V
• establish and conduct a proper M&V mechanism for each ESM
• The M&V plan, energy and variables data collection and savings analysis documentation
7.6 Conduct M&V
7.7 Develop Motivation Strategy
• internal competition & external awards
• competition recognition
• financial rewards
• environment and social responsibility
• performance standard
7.8 Create Communication Plan
• identify platform to disseminate the information to the target audiences
• determine time & frequency of the communication
• identify target audiences
• specify information to be delivered
• provide platforms for staffs to provide feedback & input
7.9 Raise Awareness & Build Capacity
• general energy awareness
• energy use performance awares
• top management awareness
• training and capacity building programs
7.9 Raise Awareness & Build Capacity
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Measure Progress & Management Review

The energy management committee shall

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- Review energy management achievements using the EnMS assessment & compare the current achievements with the previous assessments
- Implement periodical EnMS internal review for at least **once a year**
  - To ensure that the system is effectively implemented and maintained, as weall as achieves the energy policy, energy objectives & targets
- Analyze energy efficiency achievements based on established EEI/EnPI
- Review benchmarking by comparing the current energy performance with baselines, targets & peers
- Verify energy & cost savings from the implemented ESMs projects with planned M&V methods
- Investigate & respond to significant deviations in energy performance
- Check the operational controls & maintenance of SEUs
- Assess awareness, knowledge & competency of staff & employees
- Evaluate the compliance of the legal requirements

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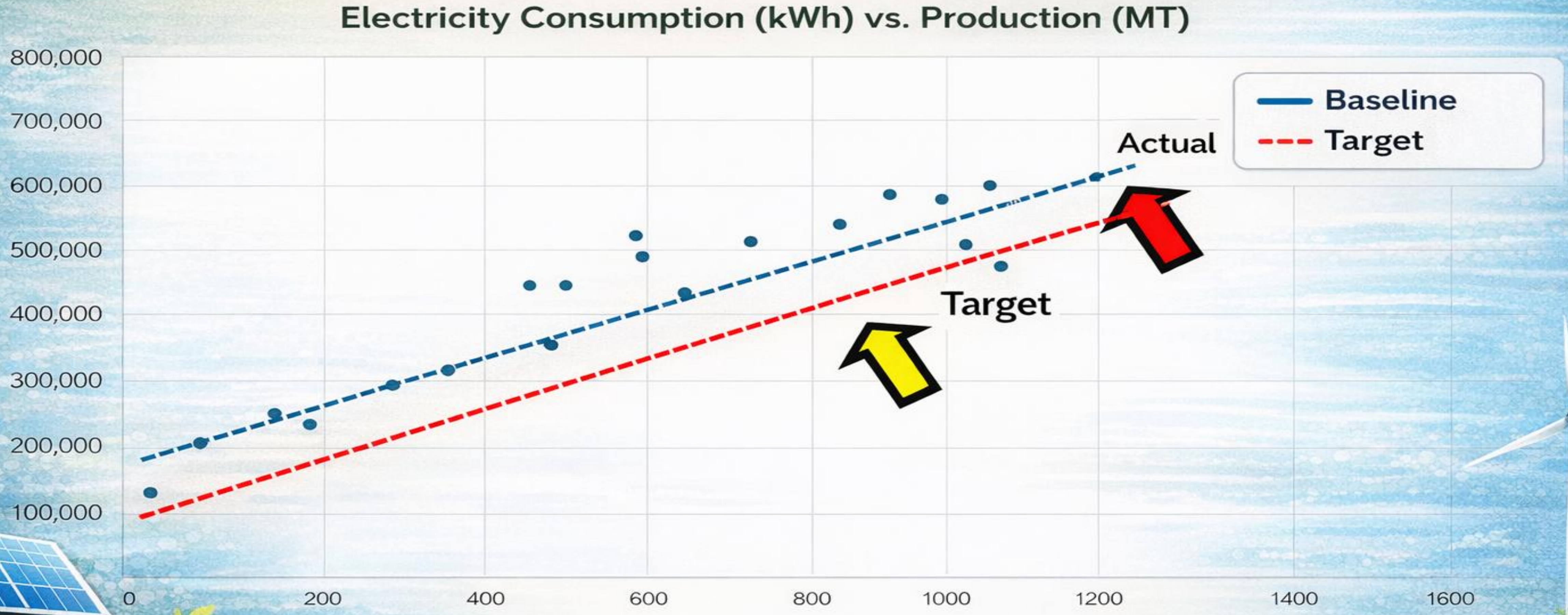
Example : Performance Evaluation based on the EnB & targets from the result of single-variate Regression Analysis



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Q & A