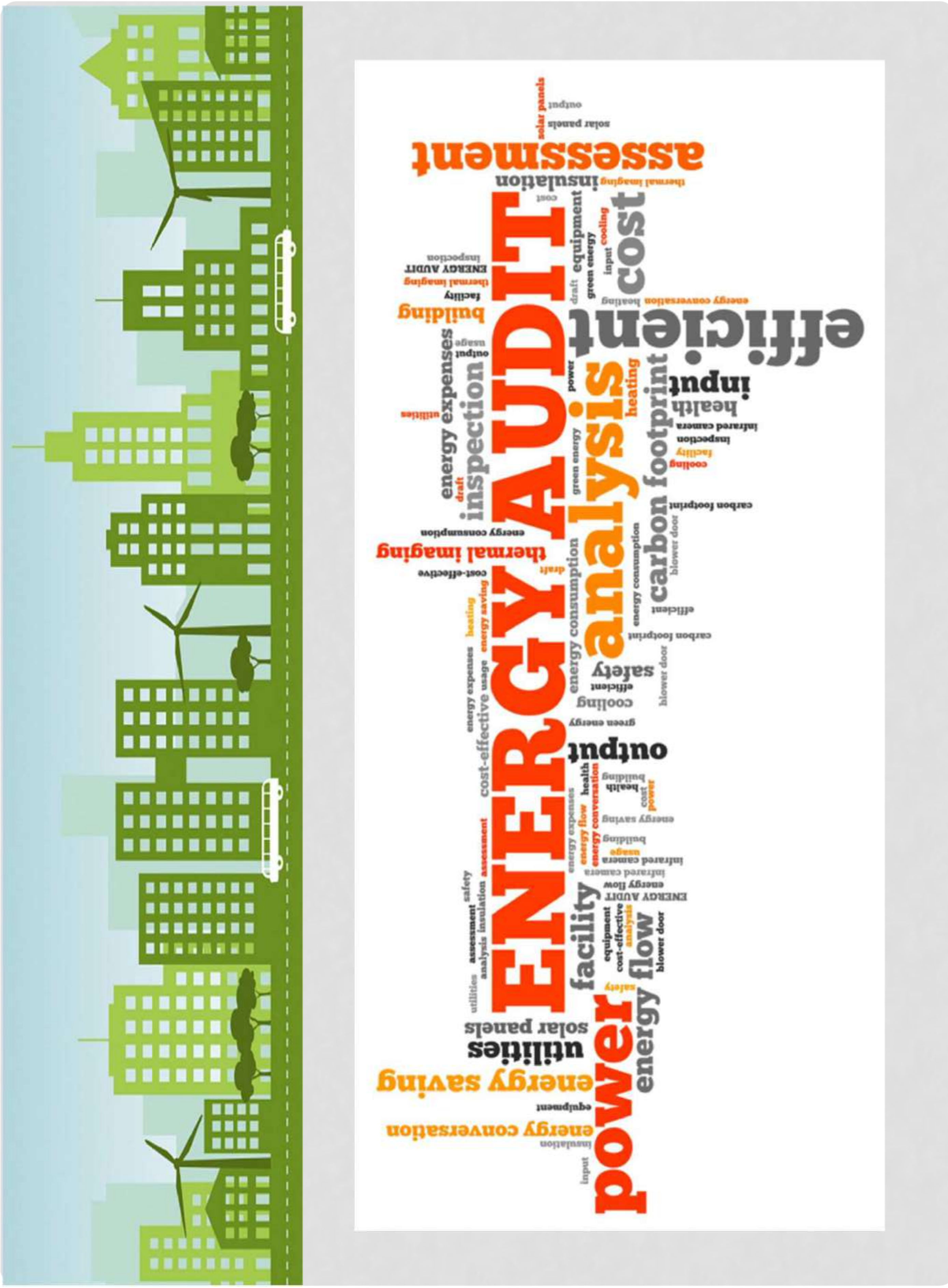

ENERGY AUDIT
analysis
power
efficient
assessment
cost
facility
flow
energy
inspection
carbon footprint
thermal imaging
energy saving
energy conversation
utilities
solar panels
output
input
building
health
safety
cooling
insulation

ENERGY AUDIT

"A systematic approach to obtain the actual energy supply and energy consumption data and to identify measures to improve energy efficiency level"

- A very effective for energy management and improvement
- To define and pursue comprehensive energy management program in the implementation of EMS

ADVANTAGES OF ENERGY AUDIT

Through energy audit, you can:

- Promote awareness in energy efficiency
- Identify the cost of energy use
- Identify and minimize wastage
- Making changes to procedure, equipment and system to save energy
- Retrofit energy efficiency technologies
- Protect the environment by reducing power generation
- Reduce running costs

GOALS OF THE ENERGY AUDIT

- Clearly identify types and costs of energy use
- Understand how that energy is being used and possibly wasted
- Identify and analyze more cost-effective ways of using energy

  - improve operational techniques
  - new equipment

WHY CONDUCT ENERGY AUDIT?

- To develop database
- To determine if energy is being used efficiently
- Identify opportunities for saving energy
- Identify cost savings
- Highlight potential improvements to existing systems
- Assist in planning for future expansion

TYPES OF ENERGY AUDIT

Detailed Audit
- Thorough data and site analysis
- Complete measurements
- More reliable energy saving potential estimation
- ESMs with high capital investment
- Detail financial analysis
- Conceptual design of proposed measure
- Involving financing and contractual documents

Preliminary/Simple Audit
- Walk-through
- Simple measurements
- No/low cost
- Simple financial analysis

PRELIMINARY ENERGY AUDIT

- A relatively quick exercise to:
  - Establish energy consumption in the organization
  - Estimate the scope for saving
  - Identify the most likely (and the easiest areas for attention
  - Identify immediate (especially no-/low-cost) improvements/ saving measures
  - Identify areas for more detailed study/measurement
- Uses existing, or easily obtained data

PRELIMINARY AUDIT

- Scope of work for preliminary audit is as follows:

✓Gather building wide energy use on monthly and/or annual basis

✓Derive performance indicator (kWh/m2/year for building, kW/ton for air-conditioning unit, W/m2 for lighting load)

✓Broad conclusions and recommendations

✓Written report

DETAILED ENERGY AUDIT

- Provides a detailed energy project implementation plan and evaluates all major energy using systems
- Offers the most accurate estimate of energy savings and cost
- It considers the interactive effects of all projects, accounts for the energy use of all major equipment, and includes detailed energy cost saving calculations and project costs
- One of the key elements is the energy balance
  - This is based on an inventory of energy using systems, assumptions of current operating conditions and calculations of energy use.
  - Estimated use is then compared to utility bill charges.
- Can be carried out in three phases
  - Phase I - Pre Audit Phase
  - Phase II - Audit Phase
  - Phase III - Post Audit Phase

DETAILED AUDIT

- Scope of work:

✓Follow-up from preliminary audit and report where available

✓Detailed building and system's energy input and energy use

✓Reconcilation of energy accounts with loads

✓Variation of energy on month-to-month basis

✓Energy performance indicators

✓Recommend improvement work with indicative cost and saving

✓Data Logging

✓Written report and presentation

ELECTRICAL ENERGY AUDIT

- Areas covered under electrical audit:
  - Electrical system
  - Electrical distribution system (substation and feeders only)
  - PF improvement
  - Transformer optimization
  - Cable sizing and loss reduction
  - Motor loading survey
  - Lighting system

MECHANICAL ENERGY AUDIT

- Areas covered under mechanical audit:
  - Fans and blowers
  - Exhaust and ventilation system
  - Pumps and pumping system
  - Compressed air system
  - Air conditioning and refrigeration system
  - Cooling tower system

ANALYSIS OF BILLS

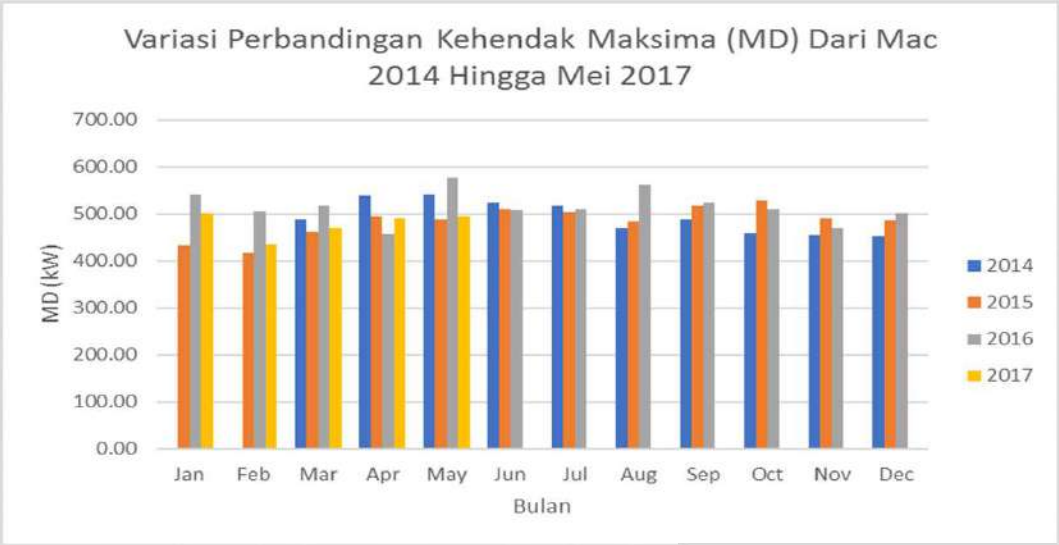
The audit must begin with a detailed analysis of the energy bills for the previous twelve months. This is important because:

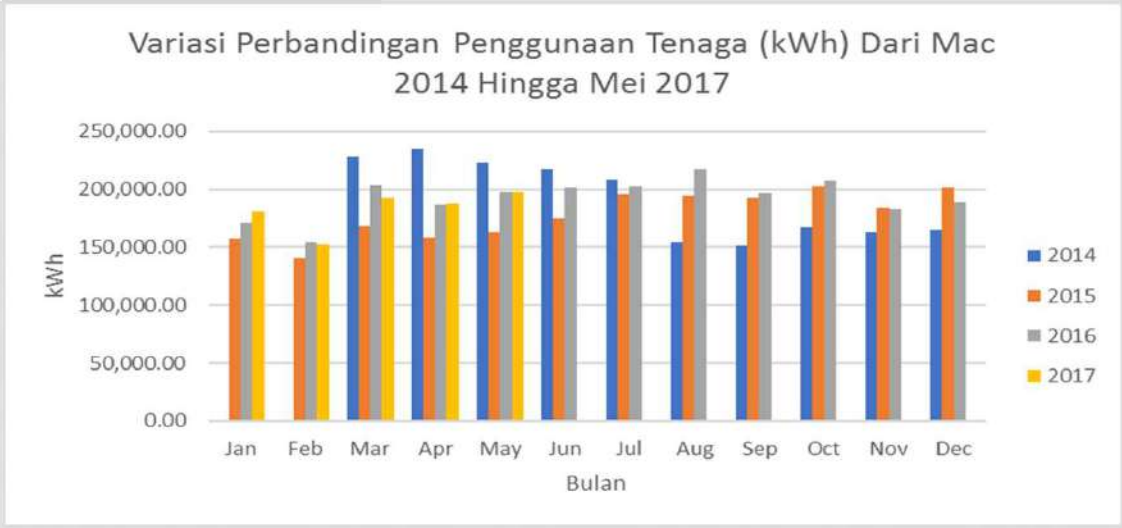
- The bills show the proportionate use of each different energy source when compared to the total energy bill
- An examination of where energy is used can point out previously unknown energy wastes, and
- The total amount spent on energy puts an obvious upper limit on the amount that can be saved
- A complete analysis of the energy bills for a facility requires a detailed knowledge of the rate structure in effect for the facility

ANALYSIS OF BILLS

- To accurately determine the costs of operating individual pieces of equipment, break energy bills down to their components e.g. demand charge and energy charges for the electric bill
- This breakdown also allows more accurate saving calculations

ANALYSIS OF BILLS





1. ENERGY INDEX/INTENSITY

- EI is one of the Key Performance Indicator (KPI) to track the performance of energy consumption:
- Defining the EI depends on the use of energy in a particular application.
- In energy intensive industries the EI will have significantly different definition to the EI used in commercial buildings.
- In general;
  - $EI = \frac{\text{Energy input}}{\text{Factor related to the energy using component.}}$

ENERGY INDEX/INTENSITY

- Sample of factors that related to energy used are:
  - Weight of product produced.
  - No. of items produced.
  - Weight of raw material used.
  - Period of productions.
  - Period of plant usage.
  - Floor area of building.
  - No. of in-patient bed per night (for hospital).
  - No. of occupied room per night (hotel).

ENERGY INTENSITY

- The factor which most accurately reflects the practical application of energy and can give the best measure of energy performance should be selected.
- In terms of normal office building:
  - EI = $\frac{\text{Energy Consumption (Electricity or Gas or etc)}}{\text{Floor area}}$

<u>kWh/m^2 (Building Energy Intensity)</u>

PRE REQUIREMENTS FOR ENERGY AUDIT

- A commitment from the top management to implement energy saving measures
  - Allocation of resources (auditor, budget)
  - Availability of information and data (records)
  - Energy audit equipment
  - Allocation of time
  - Hardware and software for data analysis
- Previous and existing energy saving initiatives information and results
- Regulatory compliance

WHAT TO BE AUDITED?

Energy Management

- Overall energy management system/practice
- Efficiency of the plant
  - Supply and consumption
- Energy loss

Facts Finding On Item To Be Improved

- General management items
- Energy using equipment

WHO CAN PERFORM ENERGY AUDIT?

Internal Personnel

- Energy Manager with the Energy Management Team
- Employees working in the energy using process/equipment

Advantages

- Minimize time to familiar and understand the plant operational conditions
- Minimize costs
- Easy access to information and data
- Familiar with energy related issues, processes, equipment and company's level of expectations (targets, performance indicators, reporting and etc)

Disadvantages

- Limited allocation of time other than main duties
- Limited expertise and knowledge in specific energy saving methods, analysis and technologies

WHO CAN PERFORM ENERGY AUDIT?

External parties

- External experts/consultants (if needed)

Advantages

- Can facilitate the Energy Management Team/EMWG
- Energy management team can learn about new knowledge and technologies in saving energy
- Minimum time to be spent by employees (focus to main duties)
- Timeliness of the completion, reporting, preparation and presentation of findings in the energy audit report.

Disadvantages

- Generally very costly
- Various level of supervisory and reporting (energy manager-auditor, management-auditor)
- Difficult to predict the quality of audit (no local accreditation for energy auditor)
- Tendency to push for certain products instead of solutions to save energy

PREPARATION

- Finalize and agree on the terms of reference for energy audit team
  - Objectives
  - Expectations from the management
  - Confidentiality
  - Frequency of progress reporting and meeting
  - Line of communication
- Introduction of energy audit team (consultant & in-house)
- Special briefing for external auditors on production, safety, health and environment requirements
- Briefing on energy audit activities and timeframe

INFORMATION REQUIRED

- Monthly electricity bills
- M&E and structural drawings of building
- Details of equipment – purchase date, rating, manuals
- Records of daily characteristics for electricity consumption
- Log-books with daily, weekly or monthly records

DEFINE AUDIT SCOPE

- Type of audit
- Boundary
- Tasks involved
- Timeframe
- Expected output

STEPS IN THE ON-SITE ENERGY AUDIT

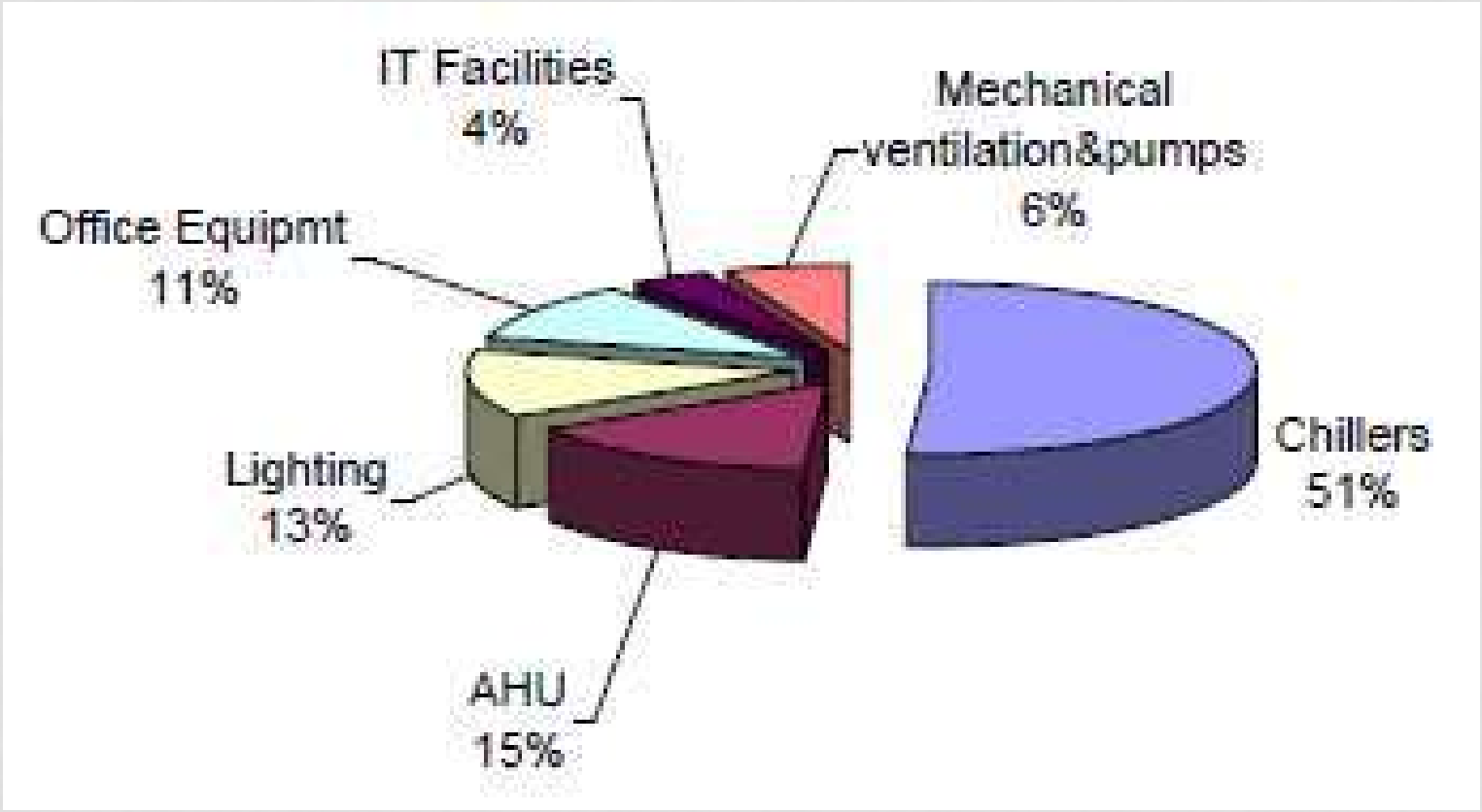
1. Identify layout and operating schedule for facility
2. Compile an equipment inventory
3. Determine the pattern of building use to show annual needs for cooling and lighting
4. Conduct a room by room lighting inventory

PREPARE ENERGY BALANCE DATA AND INFORMATION

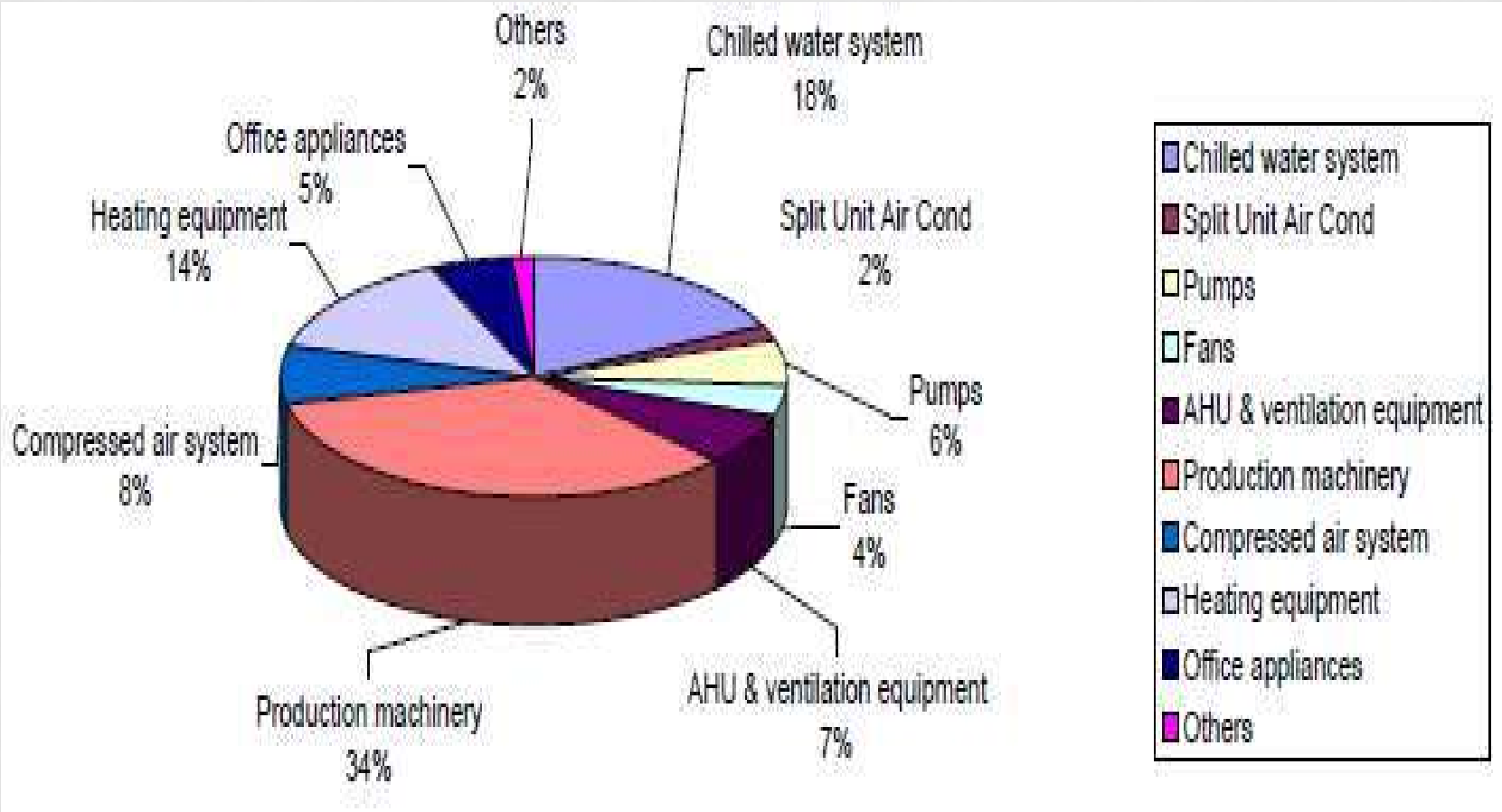
- Energy supply and consumption data

- Apportioning of energy consumption by:
  - Type of energy – fuel, electricity
  - Equipment/system – production machinery, motor, air conditioning, lighting and etc.
  - Applications – production facilities, offices, tenants

LOADS DISTRIBUTION-BUILDING



LOADS DISTRIBUTION-FACTORY



IDENTIFY ENERGY SAVING MEASURES

- Identification of energy saving measures to eliminate/minimize energy wastage to improve energy performance

Review existing/previous ideas - brainstorming and value analysis

Conceptual ideas, develop and refine measures

Communication with manufacturers/technology experts for more efficient technologies solutions

CALCULATE ENERGY SAVING POTENTIALS

- Calculate projected energy saving potentials in energy unit and convert into RM!

- Use data from measurements/manufacturers' information/data analysis to estimate potential saving values

POTENTIAL SAVING MEASURES

Measures	Examples
No cost	▪ Adjustment of space temperatures ▪ Keeping doors and windows in air-cond spaces closed ▪ Switching off unnecessary lights
Low cost	▪ Use of energy efficient motors ▪ Maximising daylight ▪ Chiller optimisation
High cost	▪ Chiller replacement ▪ Retrofit of lighting system ▪ Building envelope retrofit

OUTPUT OF ENERGY AUDIT

- Report containing Energy Saving Measures (IDEAS) proposals and recommendations
- Provide evidence of profitability with simple calculations
- Summarise results for decision makers

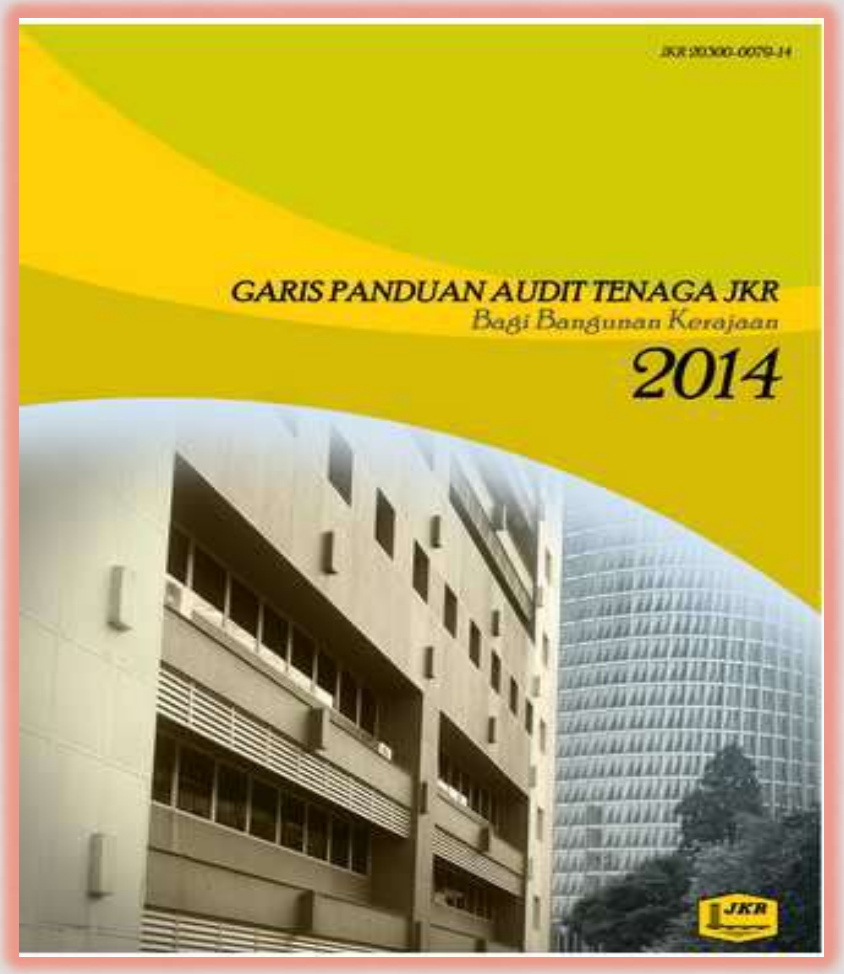
PREPARE ENERGY AUDIT REPORT

- The energy audit report details the final results of the energy analysis and provides energy cost saving recommendation
- The length and detail of this report will vary depending on the type of facility audited
- An audit should have a detailed explanation of the EMO's and benefit-cost analysis

ENERGY AUDIT REPORT FORMAT

- Executive Summary
- Brief summary of recommendations an
- Description of the audited premise/manufacturing process
- The historical energy use related to the audited premise, occupancy or productions of the manufacturing facilities
- The current energy use apportioned by the uses
- The energy saving measures including their implementation costs and estimated savings.
- Strategy for implementing the recommended energy saving measures
- Achieved savings after implementation

DOKUMEN YANG BERKAITAN



GARIS PANDUAN AUDIT TENAGA

Proses Audit Tenaga

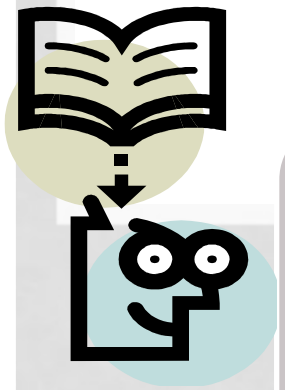
Melibatkan pelbagai Disiplin

Sistem & Peralatan di Bangunan

Pengenalan GPAT

OBJEKTIF GPAT

SKOP : GPAT



Boleh digunapakai di mana-mana bangunan kerajaan diplih/tertaluk kepada Akta Penggunaan Tenaga

Boleh dijadikan panduan Pengurus Tenaga sesuatu bangunan untuk memuatkan Program Audit Tenaga di dalam Pengurusan Tenaga

Rujukan untuk pentauliahan Pengurus Tenaga Elektrik Berdaftar

TANGGUNGJAWAB & PERANAN

Ketua Pasukan Audit Tenaga (KPAT)

Pasukan Audit Tenaga (PAT)

GPAT

Bil	Cawangan	Disiplin	Skop Kerja
1.	Caw. Kej. Elektrik (CKE)	Elektrik	Sistem Lampu (Luaran & Dalaman), peralatan pejabat & domestik, Analisa Tarif
2.	Caw. Akitek (CA)	Akitek	Sistem Pasif & kaji selidik keselesaan pengguna
3.	Caw. Kej. Mekanikal (CKM)	Mekanikal	Sistem Penghawa Dingin, sistem Lif dan Sistem pam air
4.	Caw. Alam Sekitar & kecekapan Tenaga (CASKT)	Pelbagai	Ujian Infiltrasi Bangunan
5.	Caw. Fasiliti Senggara Bangunan (CFSB)	Pelbagai	Pecahan Tenaga Keseluruhan, Imbangan Tenaga keseluruhan & Sistem Pengurusan Tenaga

PROSES KERJA

Bil.	Proses Kerja	Audit Tenaga Awalan	Audit tenaga Terperinci
1.	Analisa Meja (*Desktop Analysis)*	√	X
2.	Pemeriksaan secara visual	√	√
3.	Mesyuarat permulaan	√	√
4.	Pengumpulan Data *(Power Logger)*	X	√
5.	Pengagihan beban kegunaan akhir	X	√
6.	Langkah penjimatan tenaga (Tanpa kos)		√
7.	Mengenalpasti & mencadangkan langkah penjimatan tenaga (Dengan Kos)	√	√
8.	Pelaporan & penyampaian	√	√

SENARAI PERALATAN PENGUKURAN

Power Logger

Clamp Meter

Sling Thermometer

Lux Meter

Data Logger

CO2 Meter

TATACARA KERJA AUDIT TENAGA

- Merekod data penggunaan tenaga menggunakan peralatan Power Logger
- Analisa tarif elektrik
- Pengiraan pecahan penggunaan tenaga bangunan
- Pengiraan intensity tenaga bangunan
- Pengiraan penjimatan tenaga dan tempoh bayar balik
- Kaedah pengukuran bagi system lampu
- Kaedah merekod data bagi peralatan pejabat dan domestik
- Kaedah pengukuran sistem mekanikal (penyaman udara, lif dan pam)
- Kaedah pengukuran penyusupan udara luar ke dalam bangunan
- Kaji selidik keselesaan pengguna

AUDIT TENAGA DI BANGUNAN – BANGUNAN KERAJAAN – CASE STUDY

- Pejabat Kesihatan Negeri, Negeri Sembilan.
- JKR Worksyop, Jln Chan Sow Lin, KL.
- Pejabat Jabatan Kesihatan Daerah Klang & Klinik Kesihatan Taman Botani Klang.
- Bangunan SUK Selangor (SSAS).

THANK YOU