Energy Efficiency Training - Mozambique

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UNEP DTU PARTNERSHIP | COPENHAGEN CENTRE ON ENERGY EFFICIENCY
SEforALL EE HUB

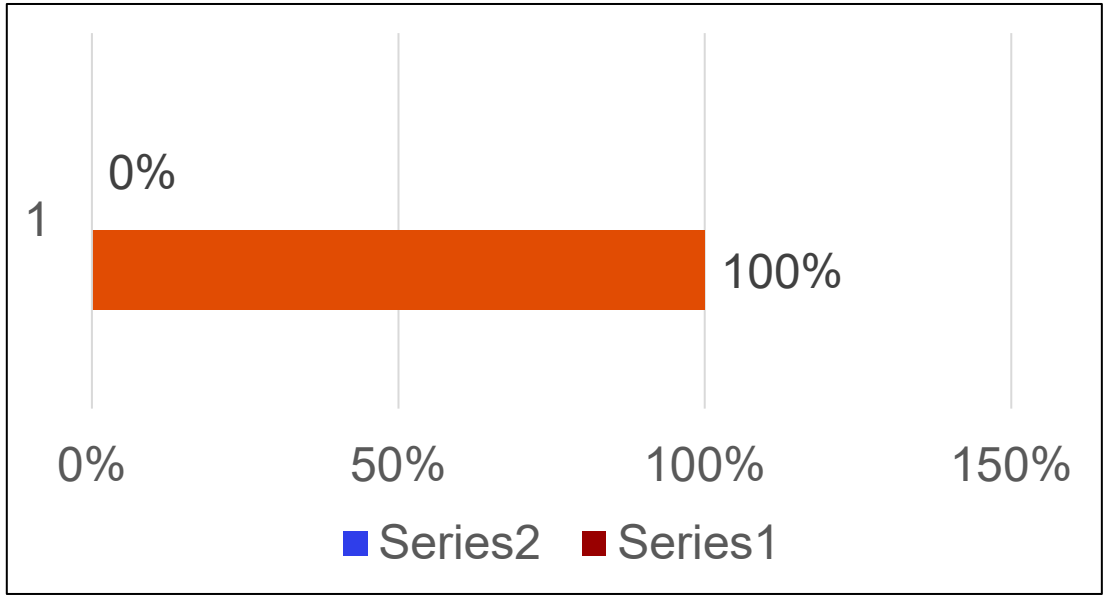
ELECTRICIDADE DE MOCAMBIQUE, E.P.

Scheduled Topics

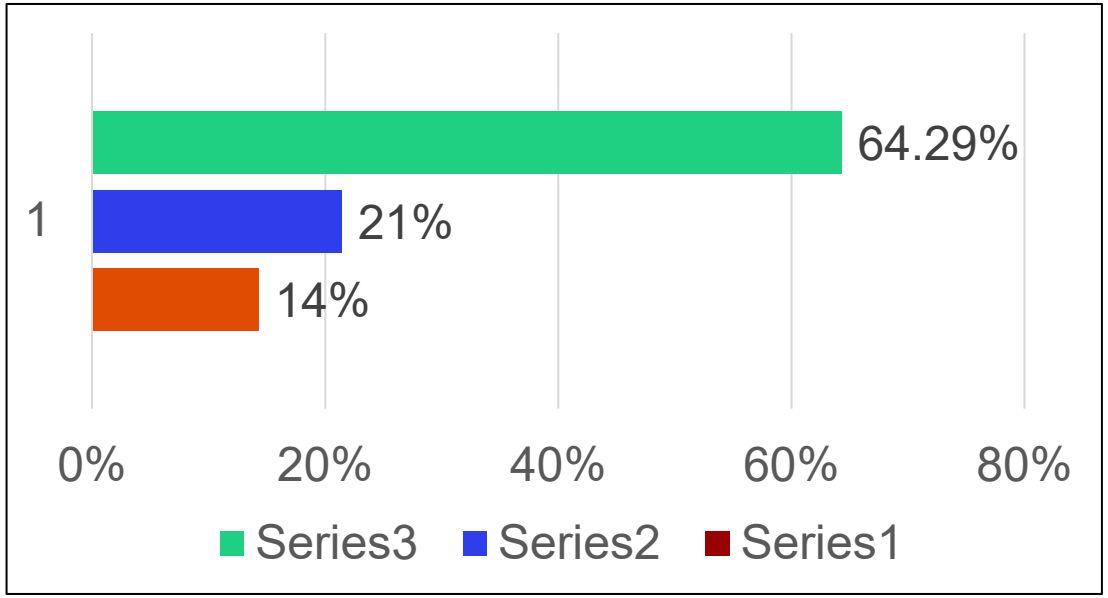
Day	Module	Topic
12 November 2020	1.1	What is Energy Efficiency
16 November 2020	1.3	EE Strategic Planning – Part 1
19 November 2020	**1.4**	**Energy Audit and Management**
24 November 2020	2.2	Energy Audit and Management for Buildings
26 November 2020	2.5	Energy Efficiency - HVAC systems

Email: rradu@dtu.dk

Poll results on 12 November 2020 session.



Are you aware of the term energy efficiency?



Do you work in energy efficiency related activities?

What?

Why?

When?

Energy Audit and Management

Where?

How?

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Energy Audit and Management - What ?

Energy Audit and Management – What?

Energy Management:

"The judicious and effective use of energy to maximize profits (minimize costs) and enhance competitive positions"

Objective:

- To minimise energy costs / waste without affecting production & quality
- To minimise environmental effects.

Source: Cape Hart, Turner and Kennedy, Guide to Energy Management Fairmont press inc. 1997

Energy Audit and Management – What?

Energy Audit:

"Systematic approach for decision making in the area of energy management "

"An inspection survey and an analysis of energy flows for energy conservation".

"The verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption"[1].

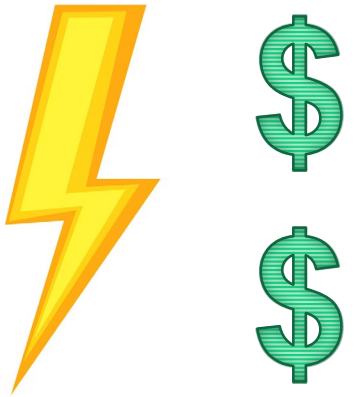
Source: [1]*Energy Conservation Act 2001, Govt. of India*

Energy Audit and Management – Why?

Energy Audit and Management – Why?

Expenses (Energy, Materials/maintenance & Labor)

Benchmarks

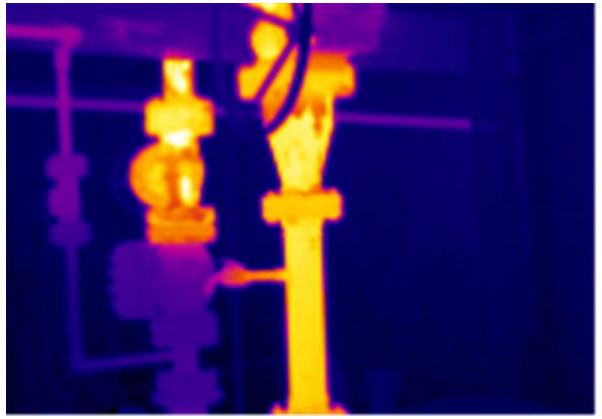


Energy cost reduction

Source: https://images.app.goo.gl/gKoSFb2bhfq15rBT8; Green Growth Energy Services; https://images.app.goo.gl/HamRwmPNmbFUhasw5;

Energy Audit and Management – Why?

Understanding Energy and Fuel



Wastage

- Energy cost reduction
- Preventive maintenance
- Quality control programs
- Provides a reference point - Benchmark.

Enables you to convert conservation ideas into realities – technical/economical/organizational

Source: https://images.app.goo.gl/83Vx64LfDBnQ8ibm8; T E R I. 2019, Mandatory Energy Audit report of Star Paper Mills Limited, Saharanpur Bangalore: The Energy and Resources Institute; 138pp. [Project Report No. 2018IB10 ; BEE, India.

Energy Audit and Management – Where ?

Energy Audit and Management – Where?

Airports

Aluminum

Building

Cement

Food

Glass

Iron and Steel

Mining

Paper and Pulp

Refinery

Pharma

Power

Municipal / Utilities

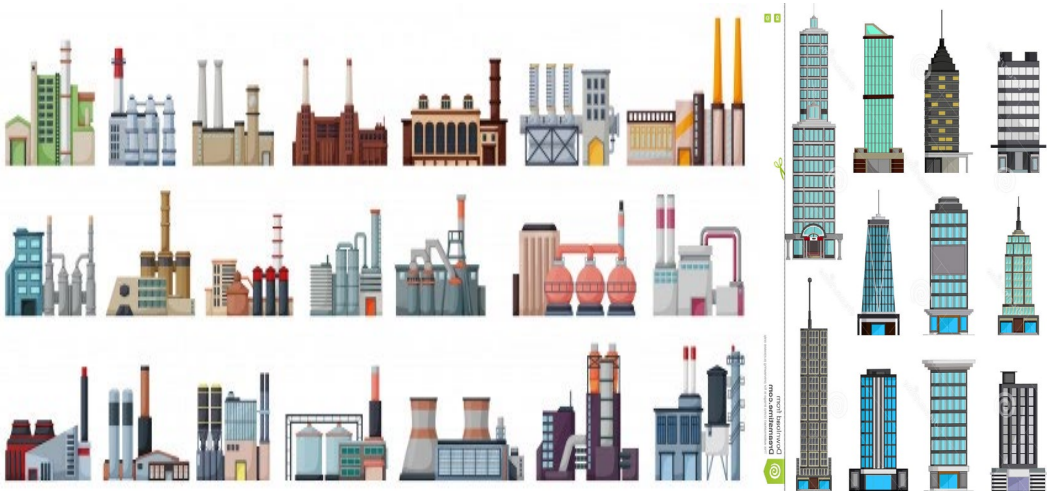
Textile

And many more.

Source: All sources available at the end of the presentation.

Energy Audit and Management – Where?

Approach



Function and type

Depth

Potential & Magnitude

Source: https://images.app.goo.gl/ZZzgovg8j3FZmqaZA; https://images.app.goo.gl/xcqzFqfsdHKc4C6T6; https://images.app.goo.gl/gyny5vWfZGv7oV8D7;

Energy Audit and Management – When ?

Energy Audit and Management – When?

Timelines:

- Energy Audit – Once in every three years
- Monitoring – Frequent as feasible. F(location, usage, equipment, criticality, etc.)
- Verification – As per individual implemented measures and during next energy audit.
- Energy Management – Continuous activity.

Energy Audit and Management – How ?

Energy Management

Energy Management

Energy management success depends on -

- Technical ability
- Monitoring system
- Strategy plan
- Top Management support

Source: BEE India;

Energy Management

- Step 1
- Step 2
- Step 3
- Step 4
- Step 5
- Step 6

Management's commitment and support

Appoint Energy Manager

Form a dedicated energy team

Have an energy policy

Source: BEE India;

Energy Management

Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Assess energy performances

Data collection and management

Establish baseline

Benchmark

Analysis and evaluation

Conduct technical assessments and audits

Source: BEE India;

Energy Management

Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Goal setting

Define scope

Potential improvement estimation

Establish goals

Source: BEE India;

Energy Management

Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Create action plan

Define technical steps

Determine roles and resources

Source: BEE India;

Energy Management

- Step 1
- Step 2
- Step 3
- Step 4
- Step 5
- Step 6

Implement action plan

- Communication plan
- Awareness
- Capacity building
- Motivate

Source: BEE India;

Energy Management

- Step 1
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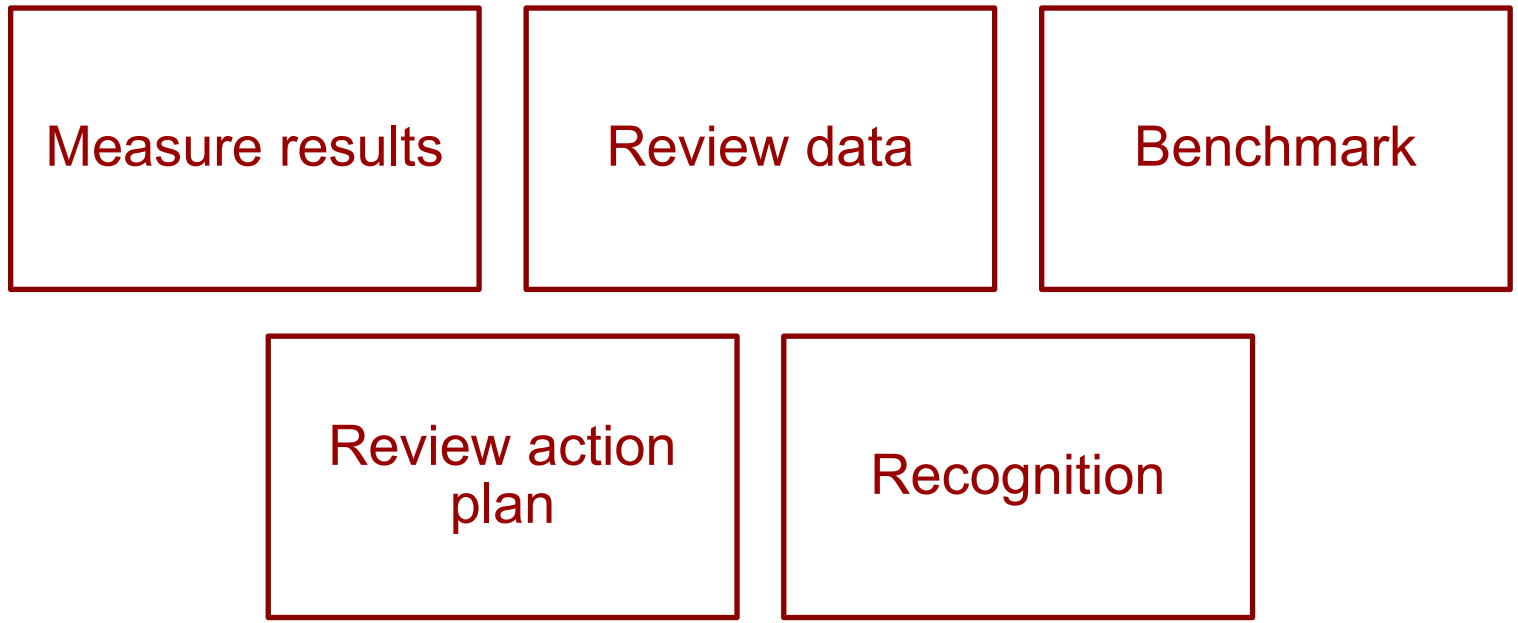
- Step 6

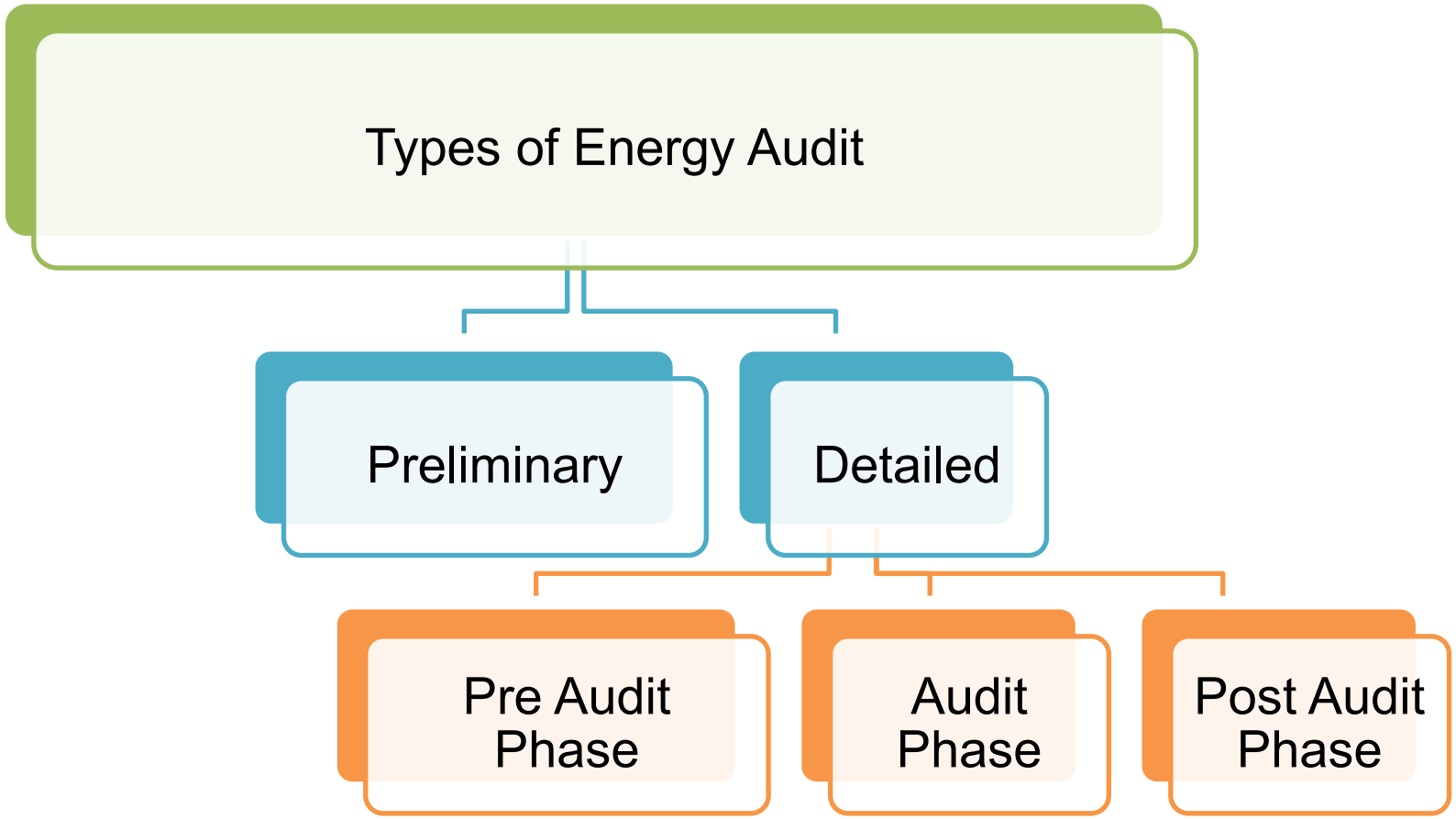
Progress evaluation and recognition



Source: BEE India;

Energy Audit

Energy Audit – How?



Preliminary Energy Audit

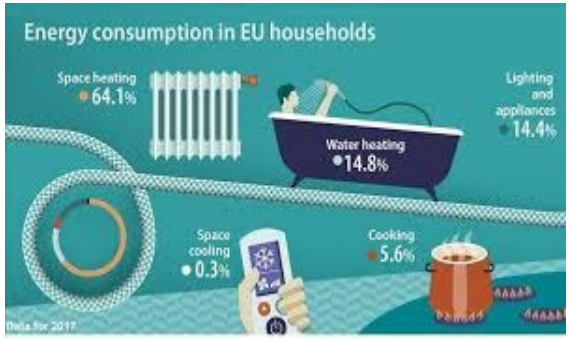
Preliminary Energy Audit

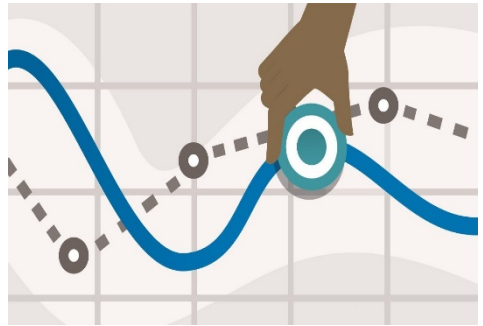
Examples:

1. Load research study for state DISCOM
    - Demand side action plan under DSM Regulation.
    - Targeting over 6000+ HT industries and 1.3 lakh+ LT industries – Engineering, Electronics, Apparel, Cement, Pharmaceutical, IT, Automobiles, etc.
    - Implement DSM intervention and analysis.
    - Build data base

2. Assessment of technology and quality upgradation scheme for MSME units – conducted by a development bank.
    - Promote EE and product quality.
    - Suitability of individual MSME units for financial incentives.

Preliminary Energy Audit - steps





Establish energy consumption → Estimate scope for saving → Identify low hanging fruits → Identify areas for in-depth study → Set a reference point

Source: https://images.app.goo.gl/LULiTUztBPyifrZb6; https://images.app.goo.gl/icMPdi34rPtjFCFo8æ; ; https://images.app.goo.gl/GDAJnAxjte7vrinX9; ; https://images.app.goo.gl/CKkTi2sv5hSA8Vkc7; https://images.app.goo.gl/1HHg4zevXisnXciU6;

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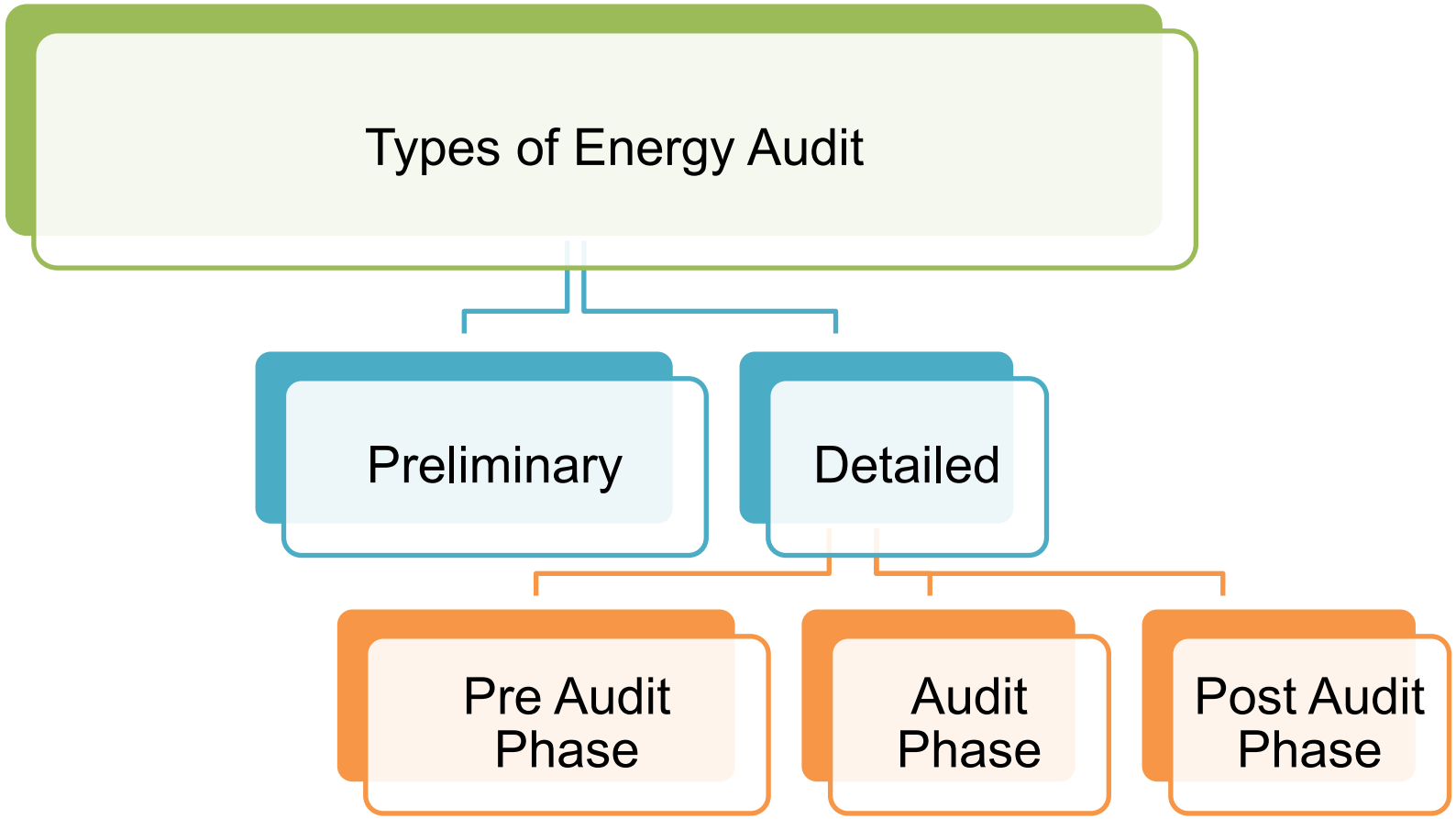
Energy Audit – How?



Detailed Energy Audit

Energy Audit Instruments

Energy audit instruments

- Power analyzers
- Anemometer
- Multi-function kit – (T, RH, P, etc.)
- Ultrasonic water flow meter
- Infra-red thermohunter
- Thermograph
- Lux meter
- Data loggers

Source: TERI, India

Pre Audit Phase

Detailed Energy Audit

Detailed Energy Audit – Pre Audit Phase

- Step 1
- Step 2
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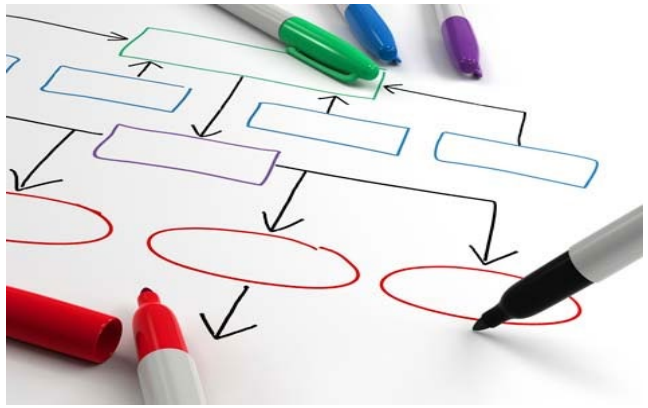

Plan & organize

Walk-through audit

Interview with energy manager, facility or production manager

Resource planning	Macro data	Familiarize

Source: BEE India; https://images.app.goo.gl/PkvESzzmrv41D5v28; https://images.app.goo.gl/ktbEAekhmmrbj1QWA; https://images.app.goo.gl/UsEExKYqwoM1tyBq6;

Detailed Energy Audit – Pre Audit Phase

- Step 1
- Step 2
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Conduct kick-off meeting – Divisional heads, associated and concerned personnel

- Cooperation
- Interaction
- Create awareness

Source: BEE India; https://images.app.goo.gl/Vg2PWNz1apkNv6BeA;

Audit Phase

Detailed Energy Audit

Detailed Energy Audit – Audit Phase

- Step 1
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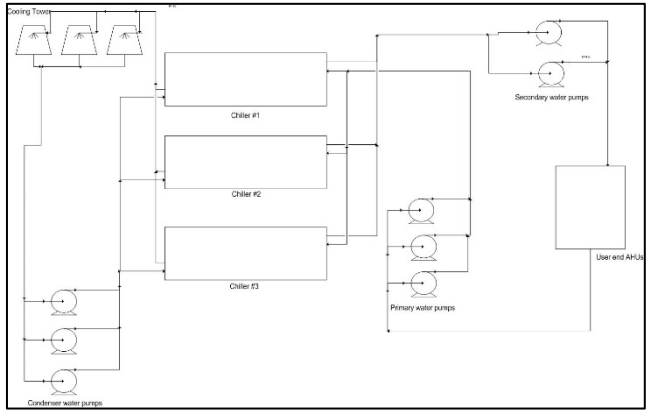
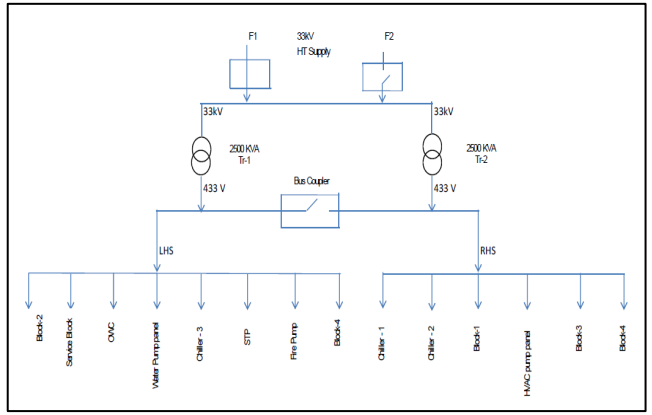
Collect primary data



Flow diagrams



Energy utility diagrams

Historic and baseline data

Flow charts and utility diagrams

Energy bill and consumption pattern

Source: BEE India; https://images.app.goo.gl/sazMnrCe76HXqjeKA;

Detailed Energy Audit – Audit Phase

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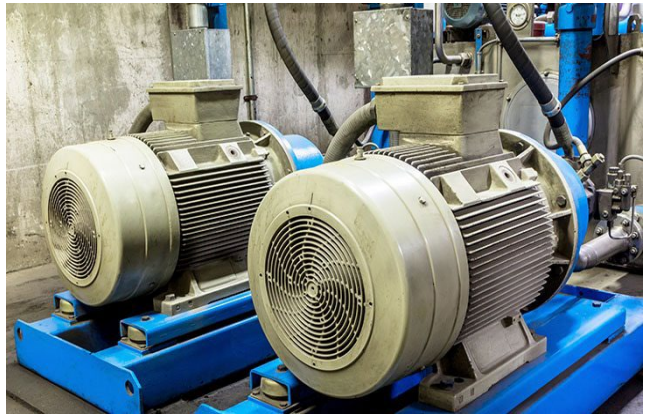

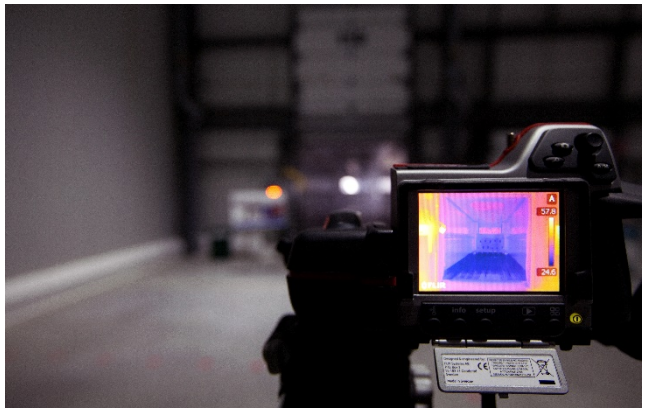

In-depth survey and monitoring

Collection for more accurate data

Confirm and compare operating and design data

Source: BEE India; https://images.app.goo.gl/8b1WHLTzNC6ipCfo8; https://images.app.goo.gl/JRtXpmToTkv3pnsx5; https://images.app.goo.gl/AwMbqGPkT8Dqxp776;

Detailed Energy Audit – Audit Phase

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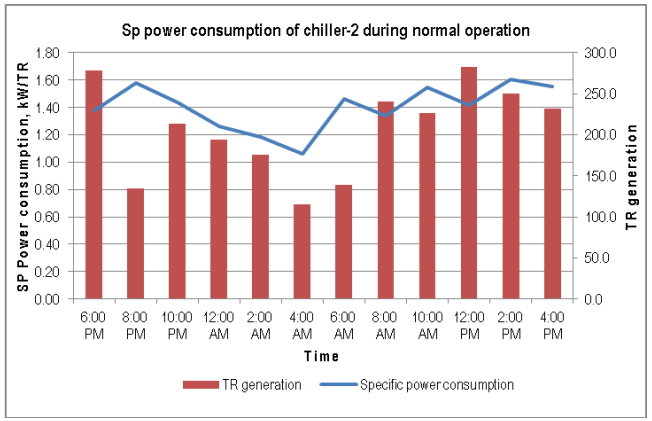

- Power monitoring
- Load variation trends
- Efficiency Performance assessment and trials

Detailed trials and Experiments for energy intensive areas

Source: BEE India; T E R I. 2013 [Project Report No. 2013IB05];

Detailed Energy Audit – Audit Phase

Step 1
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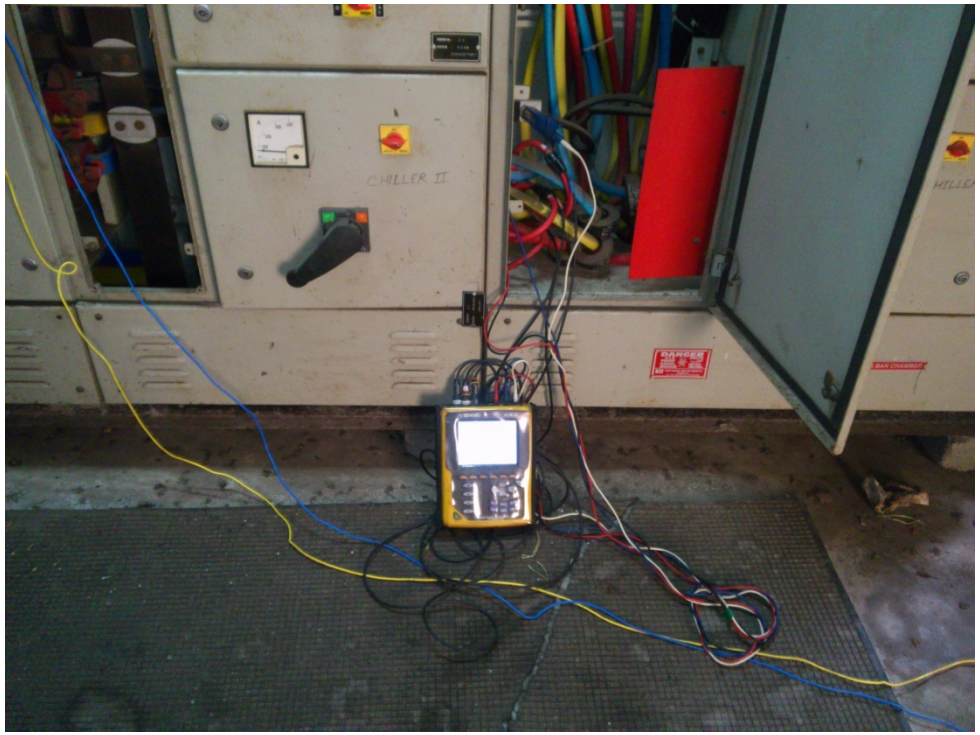
Measurements

Instantaneous power measurements carried out with portable load analyser for all the motors



Source: BEE India; T E R I. 2013 [Project Report No. 2013IB05];

Detailed Energy Audit – Audit Phase

- Step 1
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Measurement using Ultrasonic flow meter on a chilled water line

Source: BEE India; T E R I. 2013 [Project Report No. 2013IB05];

Detailed Energy Audit – Audit Phase

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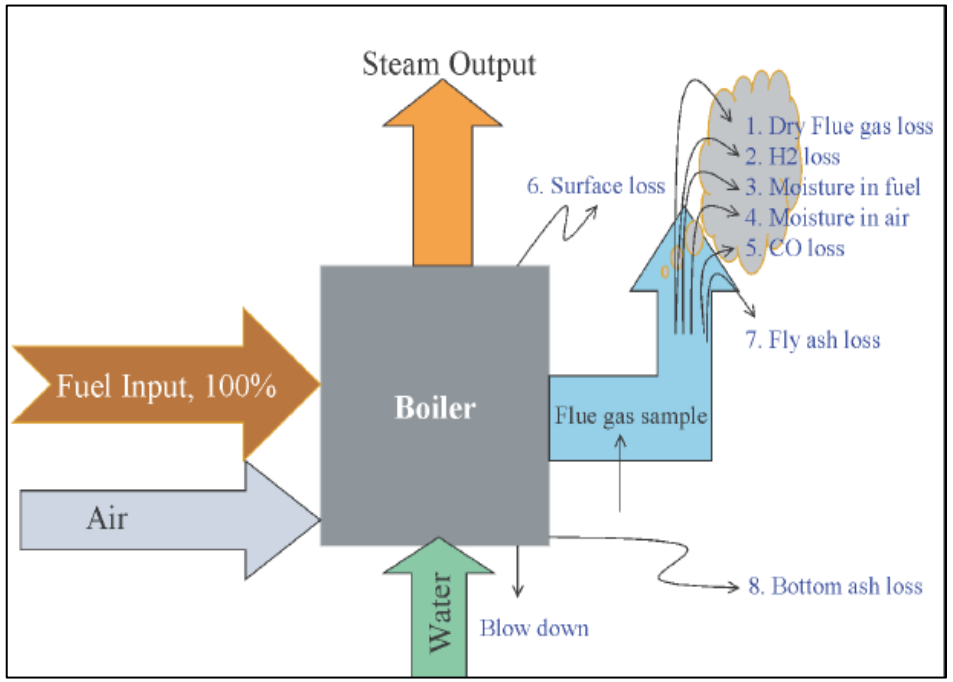

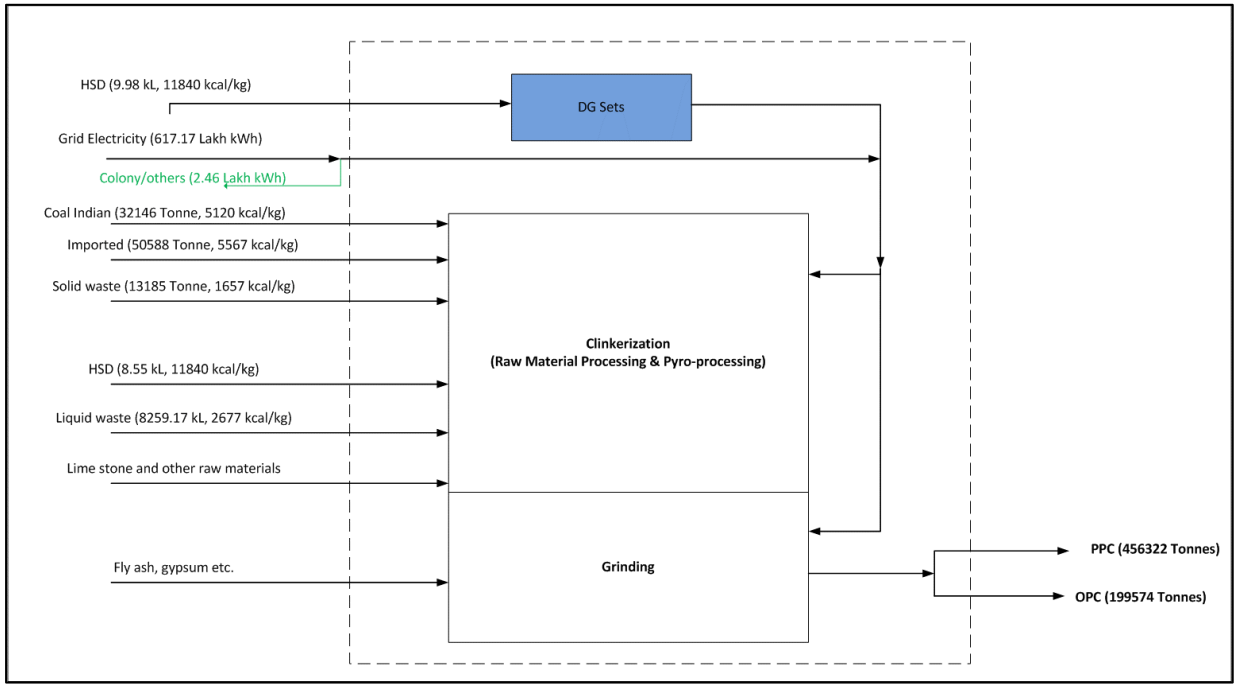

Analysis of energy use – Energy and Material balance, waste analysis

Source: BEE India;

Detailed Energy Audit – Audit Phase

Step 1
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Step 7
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S.No	Energy Conservation Measures
Electrical Systems	
1	Parallel operation of Transformer-1 & 2
2	Install capacitor banks near chillers
Refrigeration and Air Conditioning systems	
2	Switch of primary chilled water pump
3	Replace process chilled water pump with optimum sized pump
4	Bypass VFDs of AHUVFM01, AHU 521, AHUVFM6, AHUVFM5, AHU516, AHU511, CSU01
Fans blowers and Vacuum pumps	
6	Avoid fresh air inclusion at the suction of the scrubber blower for Scrubber 35, 37,38, 39, Fume exhaust 3,4,7,9
7	Switch off Scrubber 27 B blower which is installed improperly
Compressed air system	
8	Replace S 16 air compressor with S 14 air compressor
Lighting	
9	Replace the existing 2 x 36 W T8 FTLs lamps with energy efficient 2 x 16 W T8 LED tube lights

Consolidate measures

Brainstorm

Contact vendors/ suppliers/technology providers

Identify and develop energy conservation opportunities

Source: BEE India; https://images.app.goo.gl/tndVf5Y6w8sw7hpv8; https://images.app.goo.gl/mEUhN4TTRbUvp5GV9;

Detailed Energy Audit – Audit Phase

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Type of Recommendations	No. of Recommendations	Annual Saving Potential, Rs. Lakh	Cost of Implementation, Rs. Lakh	Payback Period, Years
Short term investment, payback less than I Year	10	20.12	4.98	0.2
Medium investment, payback between 1- 3 years	5	10.06	20.7	2.1
Long investment, payback more than 3 years	2	11.57	61.62	5.3
Total	14	**41.75**	**87.30**	**2.1**

$$\text{Cost savings} = \text{Energy savings} \times \text{Per unit Energy cost}$$

$$\frac{\text{Return (Benefit)}}{\text{Investment (Cost)}} = \text{ROI}$$

Cost benefit analysis

Source: BEE India; https://images.app.goo.gl/wTPuN3aAJEzznYx86;

Detailed Energy Audit – Audit Phase

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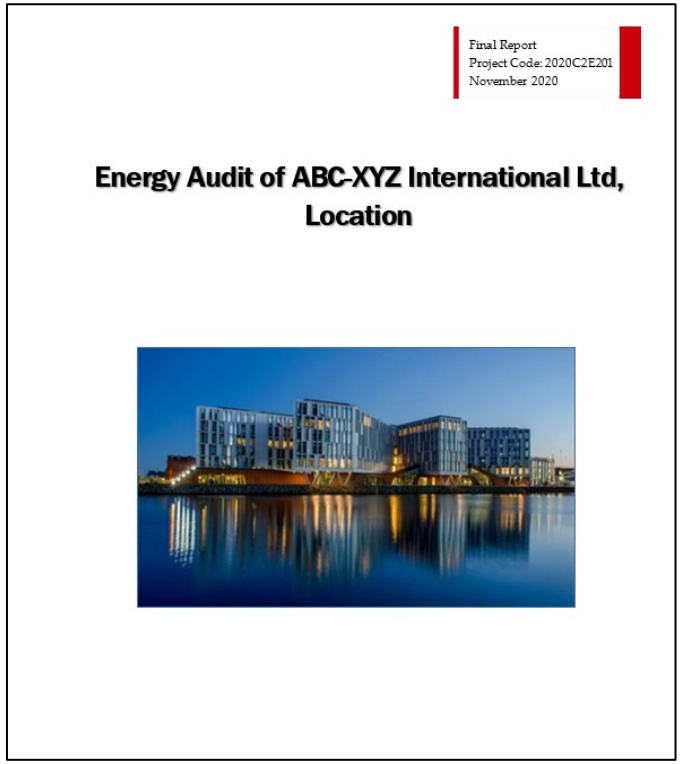


Reporting and presentation to the top management

Source: BEE India; https://images.app.goo.gl/wTPuN3aAJEzznYx86; https://images.app.goo.gl/TXswSTaHbZKuAvQ57;

Post Audit Phase

Detailed Energy Audit

Detailed Energy Audit – Post Audit Phase

Step 1
Step 2
Step 3
Step 4
Step 5
Step 6
Step 7
Step 8
Step 9
Step 10

Assist in Implementation

Follow up

Periodic review

Implementation and Follow-up

Source: BEE India;

Energy Conservation Opportunities

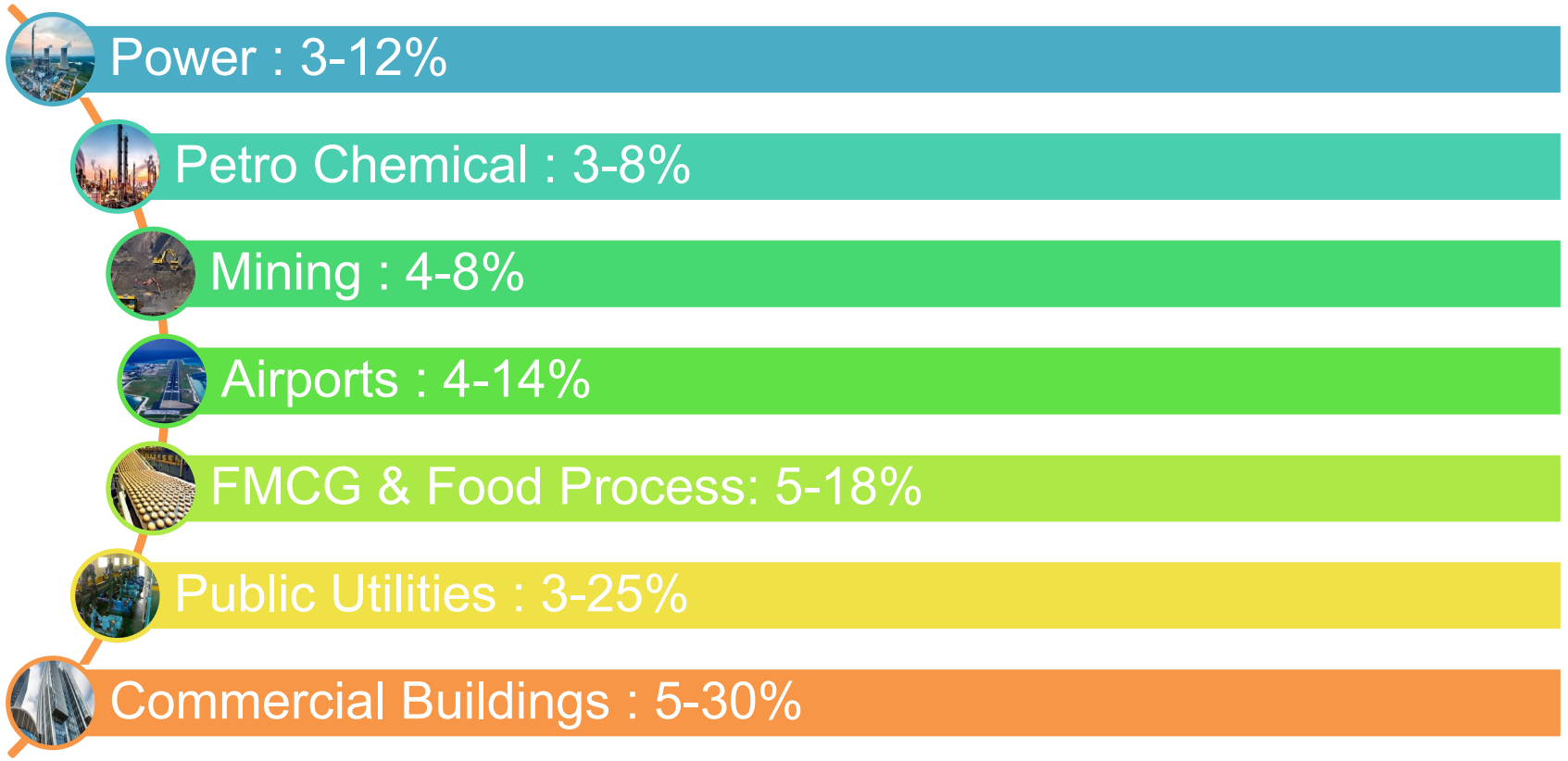
Energy conservation opportunities

Fuel	• Substitute / complement
Energy generation	• CPP / steam / thermic fluid • EE conversion
Energy distribution	• Cable networks / quality • Pipeline networks, etc.
Energy usage	• Efficient process / integration
Feasibility	• Technical / Economical

Source: BEE India;

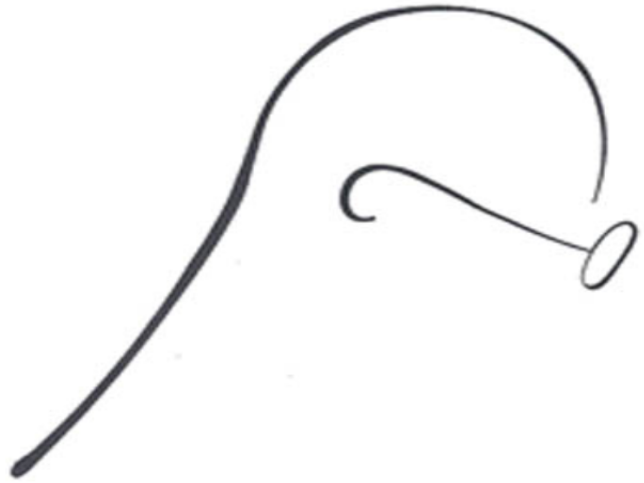
Potential assessment

Potential assessment



Cement, Aluminum, Iron& Steel, Chlor-Alkali, Textiles, Paper and Pulp, Pharmaceuticals, etc.

*Note: Based on first hand data analysis of 2000+ Energy Audits



Be the change you want to see in the world

Thank You

Email: rradu@dtu.dk

List of references used

Slide : Energy Audit and Management – Where?, Picture references link

- Power : https://images.app.goo.gl/J9huk7aj6EVqGEdc7
- Petrochemical: https://images.app.goo.gl/VH5hf6DdskyNGUHY
- Mining: https://images.app.goo.gl/7LejD3jX2F9jbBobA
- Food process: https://images.app.goo.gl/YsPssGcwStNHRPM56
- Public utilities and municipalities : https://images.app.goo.gl/rv5p1UKEGE5fWEC68
- Commercial buildings: https://images.app.goo.gl/nQvKWhsCEXsCQ9Lj7
- Aluminium: https://images.app.goo.gl/TWfmacPjxRxG642d6
- Cement: https://images.app.goo.gl/TNJFc71BBWeZtFHw7
- Iron and steel: https://images.app.goo.gl/bbUnrXXmDVMJyYRz7
- Textiles: https://images.app.goo.gl/JyLmtyCjtstczVVz8
- Paper and pulp: https://images.app.goo.gl/QFBWE4BFBnp49p458