ENERGY, EFFICIENCY & ENHANCEMENT (e^3)

A presentation by SBEEC

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What is e^3 :

⇒ **e^3** is a program for energy efficiency enhancement resulting in reduced cost and improved energy performance, based on energy monitoring, energy audits, and energy performance indicator dashboards across the enterprise.

⇒ The **e^3** program ensures continual improvement to enhance an organization's energy efficiency and performance.

⇒ Energy data measurement is a key component to implement **e^3** in every organization, industry, commercial building and housing society.

⇒ An energy efficiency program that in line with ISO 50001 procedures ensures feedback and measurement of energy consumption patterns and trends with the aim of identifying opportunity areas in order to reduce energy usage, wastage and costs.

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Why e^3 is Important?

⇒ Reduced operating costs.

⇒ Improved reliability and productivity.

⇒ Reduced environmental impact.

⇒ Reduced exposure to rising energy costs.

⇒ Improved corporate image.

⇒ Alignment with ISO 50001 Energy Management System(EnMS).

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ISO 50001-2018 Energy Management System

ISO 50001 provides a framework of requirements for organizations to:

⇒ Develop a policy for more efficient use of energy.

⇒ Fix targets and objectives to meet the policy.

⇒ Use data to better understand and make decisions about energy use.

⇒ Measure the results.

⇒ Review how well the policy works, and Continually improve energy management.

⇒ To implement and use an ISO 50001:2018 Energy Management System, there are a number of procedures, forms and work instructions that must be developed.

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Time frame : ISO 50001-2018 Energy Management System

Task No.	Deliverables/ activity	Timeline
Task – 1	**Preparation of detail work plan**	1 Week
Task – 2	**Conducting Orientation Meeting**	
Task – 3	**Planning and Commitment:**	1 Week
	Define scope and boundaries of the EnMS	
	EnMS Team Formation, roles and responsibilities & budget allocation	
	Development and Approval of Energy Policy	
Task – 4	**Provide training to the energy team on energy management system**	1 week
	EnMS Awareness Session,concepts and approaches to an EnMS	
	Energy conservation and Efficiency	
	Specific Consumption & Benchmarking	
Task – 5	**System Design and Document Development:**	4 to 6 months
	Energy Management System Manual	
	Mandatory Clause Precedure 1 to 10	
	Other Supporting Documents	
Task-6	**Energy Review and Planning**	1 to 2 month
	Identity ECOs and Develop List	
	Develop Baseline and EnPI	
	Develop Objectives and Targets	
	Develop Action Plan	
Task – 7	**Implement ,Checking and Improvement:**	4 to 6 months
	Implement Communication and Training Plan	
	Review of Implementation progress	
	Internal Audit (IA) Training	
	Conduct Internal Audit	
	Actions to Close IA Findings	
	Management Review Preparation and Meeting	
Task – 8	**Evaluation of identified opportunities/ interventions iplementations, improvements in systems, investments, savings and GHG/Environmental impact**	1 month
Task – 9	**Prepare industry for Stage I and II audits and progress reporting**	1 month

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Higg Facility Environmental Module(Higg FEM)

⇒ The Higg Facility Environmental Module (Higg FEM) is a sustainability assessment tool that standardizes how facilities measure and evaluate their environmental performance, year over year.

⇒ The Higg FEM is designed to:

- Measure and quantify the sustainability impacts of a facility
- Reduce redundancy in measuring and reporting sustainability performance
- Drive business value through reducing risk and uncovering efficiencies
- Create a common means and language to communicate sustainability to stakeholders

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Higg Facility Environmental Module(Higg FEM)

Areas Covered

⇒ EMS

⇒ Energy & GHG

⇒ Water Use

⇒ Waste Water

⇒ Air Emissions

⇒ Waste

⇒ Chemical Management

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Leadership in Energy & Environment Design(LEED)

⇒ LEED is the most widely used green building rating system in the world.

⇒ LEED provides a framework for healthy, highly efficient, and cost-saving green buildings.

⇒ The latest LEED rating of 5 different areas addressing multiple projects:

- Building Design and Construction
- Interior Design and Construction
- Building Operations and Maintenance
- Neighborhood Development
- Homes

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Steps to Achieve e^3 :

Step-1 : Appoint an Energy Committee.

Step-2 : Establish the Energy policy.

Step-3 : Understanding of manufacturing process.

Step-4 : Define the Scope and Boundaries.

Step-5 : Energy Measurement Plan

Step-6 : Energy Monitoring through Entrack.

Step-7 : Energy Review.

Step-8 : Enabling the industry to achieve ISO 50001 EnMS certification.

Step-9 : Share your successes and Repeat, for continual improvement.

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Step-1 : Energy Committee

A energy committee will be responsible for:

⇒ Identifying resources required to implement the e^3.

⇒ Ensuring that the e^3 is implemented and maintained.

⇒ Reporting on the performance of the system .

⇒ Decision making

⇒ All departments should be linked together.

Step-2 : Energy Policy

A policy statement includes commitments to:

⇒ Ensure availability of information and resources needed to achieve objectives and energy targets.

⇒ Fulfill legal and other requirements related to energy efficiency, energy use and energy consumption.

⇒ Continual improvement of energy performance.

⇒ Include energy efficiency as a feature of the procurement process.

Step-3 : Understanding of manufacturing process

⇒ Walk Through the Manufacturing Processes.

⇒ Identify Inputs and Outputs of Each Process Steps.

⇒ Identify for Each Process Step

- Characteristics of Inputs
- Process Parameters
- Characteristics of Outputs
- Operating Environment

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Step-4 : Scope and Boundaries:

⇒ Which energy sources are included in the scope and which are not included.

⇒ Which parts of the organization are included and excluded.

Scope	
Which energy sources are included in the scope and which are not included.	
Included	**Excluded**
Electricity	LPG in the kitchen
Fuel Oil	transport until next year
Water	
Natural Gas	

Boundaries	
Which parts of the organization are included and excluded.	
Included	**Excluded**
Production systems	remote warehouse facility
All buildings	
All utilities	

Step-5 : Energy Measurement Plan

Energy Measurement Plan							
Meter I.D	Location / Department	SEU's	Equipment & Calibration		Monitoring / Measuring		Responsibility
			Type	Frequency	Method	Frequency	

Step-6 : Energy monitoring through Entrack

⇒ Energy monitoring is a function of axiom **"What Gets Measured, Gets Managed".**

⇒ The modern approach to energy-data collection is to fit energy monitoring systems that automatically measure and record energy consumption at short, regular intervals such as every 15-minutes or half-hour. Detailed interval energy consumption data makes it possible to see patterns of energy waste that it would be impossible to see otherwise

⇒ To improve energy performance you must monitor your energy use.

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Step-6 : Energy monitoring through Entrack

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Step-7 : Energy Review

Step-7.1 : Energy bill and sub-meter data.

Step-7.2 : Analyze Past and Present energy use.

Step-7.3 : Identify & Quantify SEU's.

Step 7.4 : Identify drivers, get data and analyze SEU's.

Step-7.5 : Develop Baselines and performance indicator for each SEU's.

Step-7.6 : Perform Technical Energy Audit.

Step-7.7 : Identify opportunities for improved performance, review and decide on action plan.

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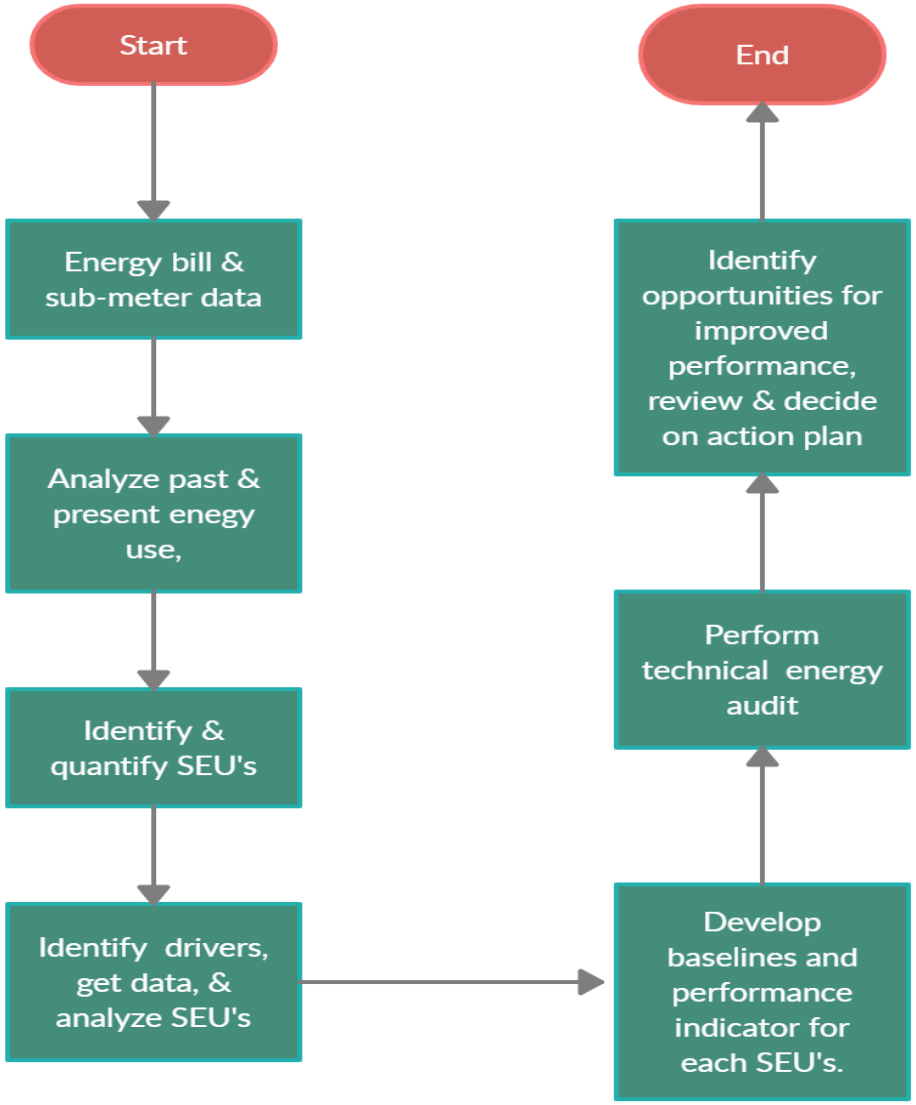
Energy Review Flow Diagram



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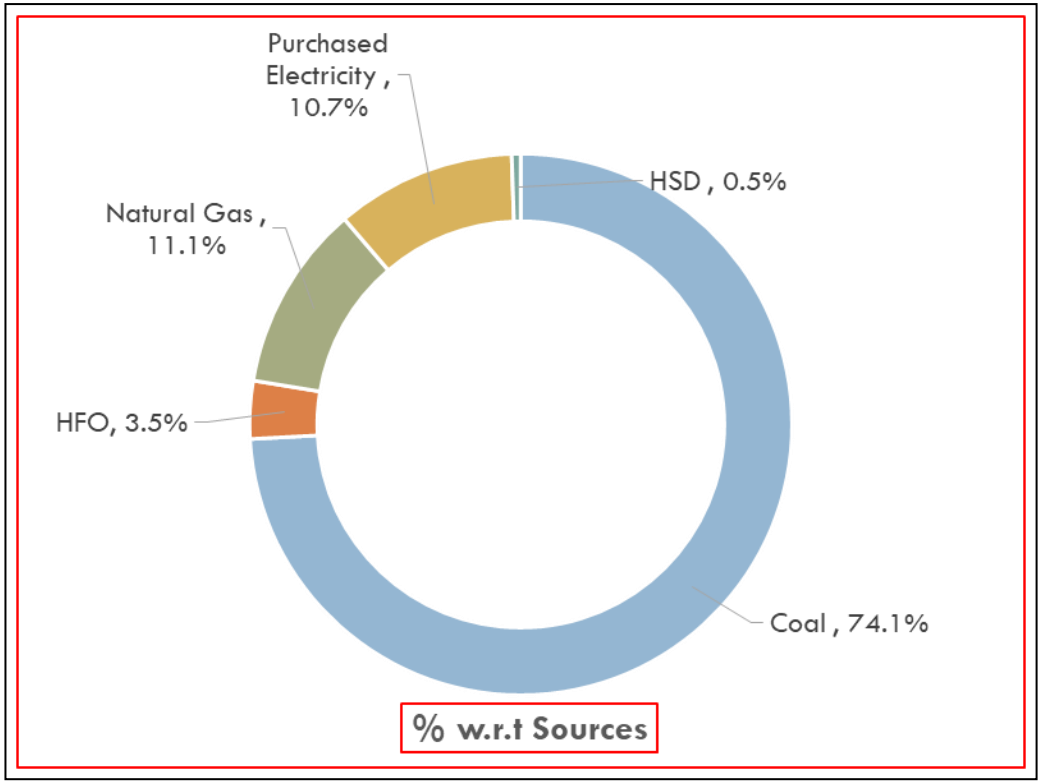
Step-7.1 : Energy bills and sub meter data

⇒ Access energy bills and sub meter data.

Sources	Value	Unit
Coal	3,676,072	kg
HFO	117,751	kg
Natural Gas	15,318	MMBTU
Purchased Electricity	4,334,080	kWh
HSD	21,708	lit.



Step-7.2 : Analyze Past and Present energy use.

⇒ The purpose of this step is to linking the energy sources to energy uses. A single energy source can be associated with multiple energy uses. Interviews with organizational personnel responsible for the operation of equipment, systems and processes can be helpful in identifying energy uses.

⇒ Once the energy uses are identified, evaluate past and present energy use and consumption.

⇒ A suitable period (e.g. twelve months or two years) is established to evaluate historic energy consumption and identify trends. The period(s) selected should be representative of the variation in organizational operations (e.g. seasonal production, occupancy levels).

⇒ It is good practice to analyze data for a period of at least one year to account for seasonal effects and other variables.

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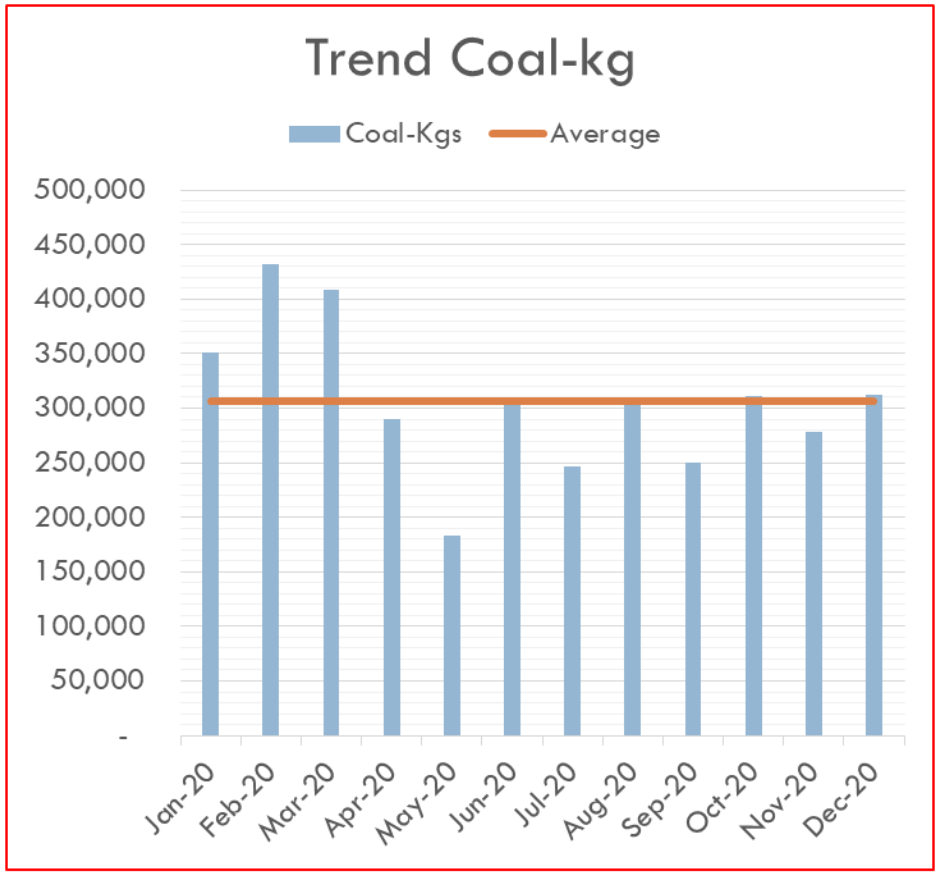
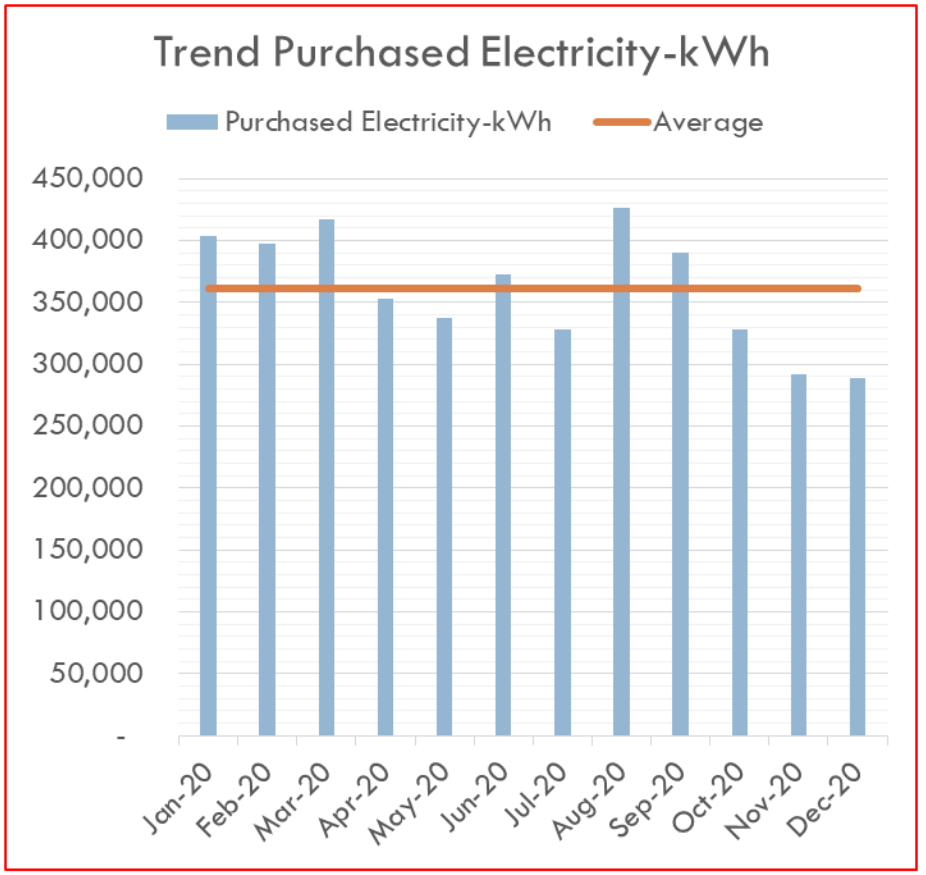
Step-7.2 : Analyze Past and Present energy use.





Step-7.3 : Identify & Quantify SEU's

⇒ The purpose of this step is to establish where most of the organization's energy is being used. Once you know which are your most significant energy uses (i.e. processes, systems, equipment, etc.), you will focus most of your efforts on those uses.

⇒ In order to identify your significant energy uses (SEUs), you need to know how much energy each process or system uses. In an ideal world you will have energy sub-meters fitted to all large energy users and can then simply use these meters to quantify the consumption of each use.

⇒ Energy use and consumption will be analyzed to identify and quantify the SEUs. This will be updated regularly

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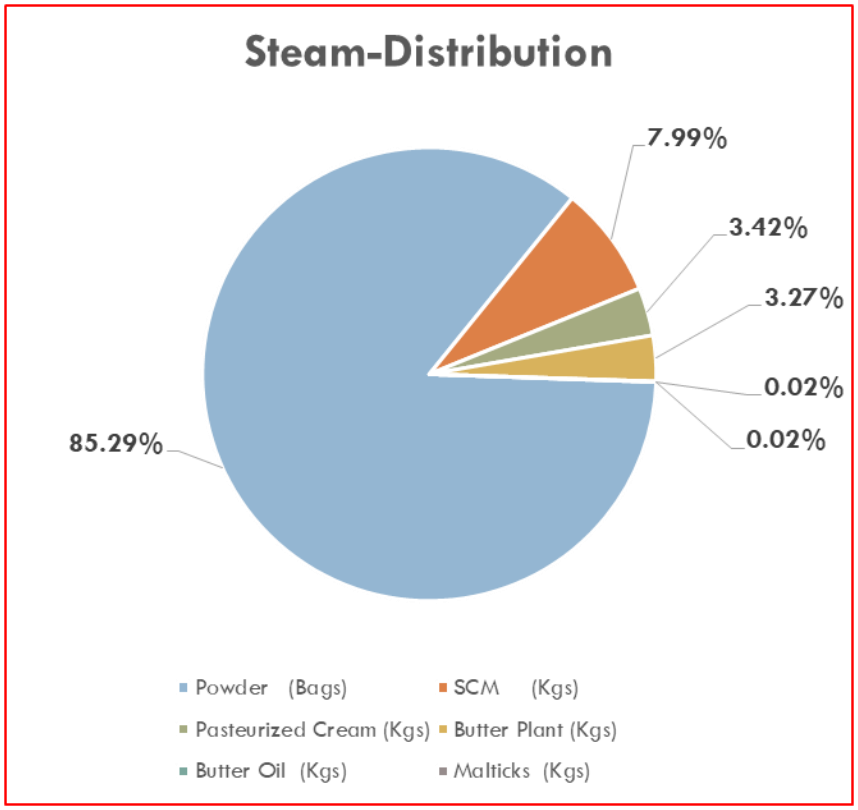
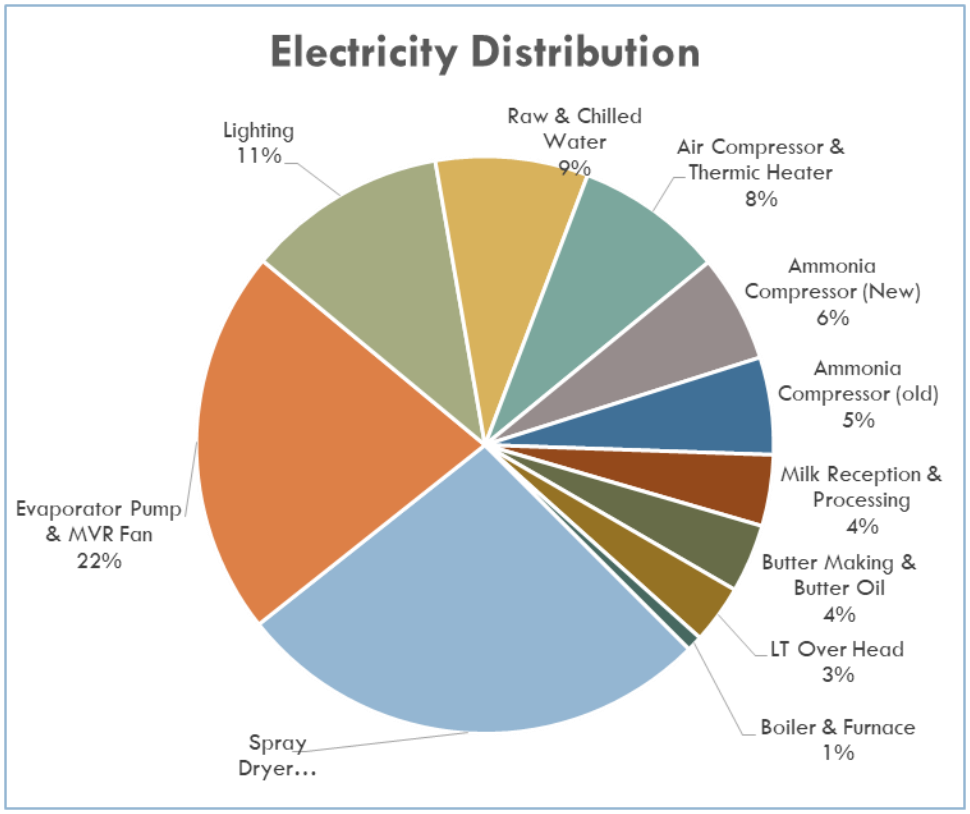
Step-7.3 : Identify & Quantify SEU's





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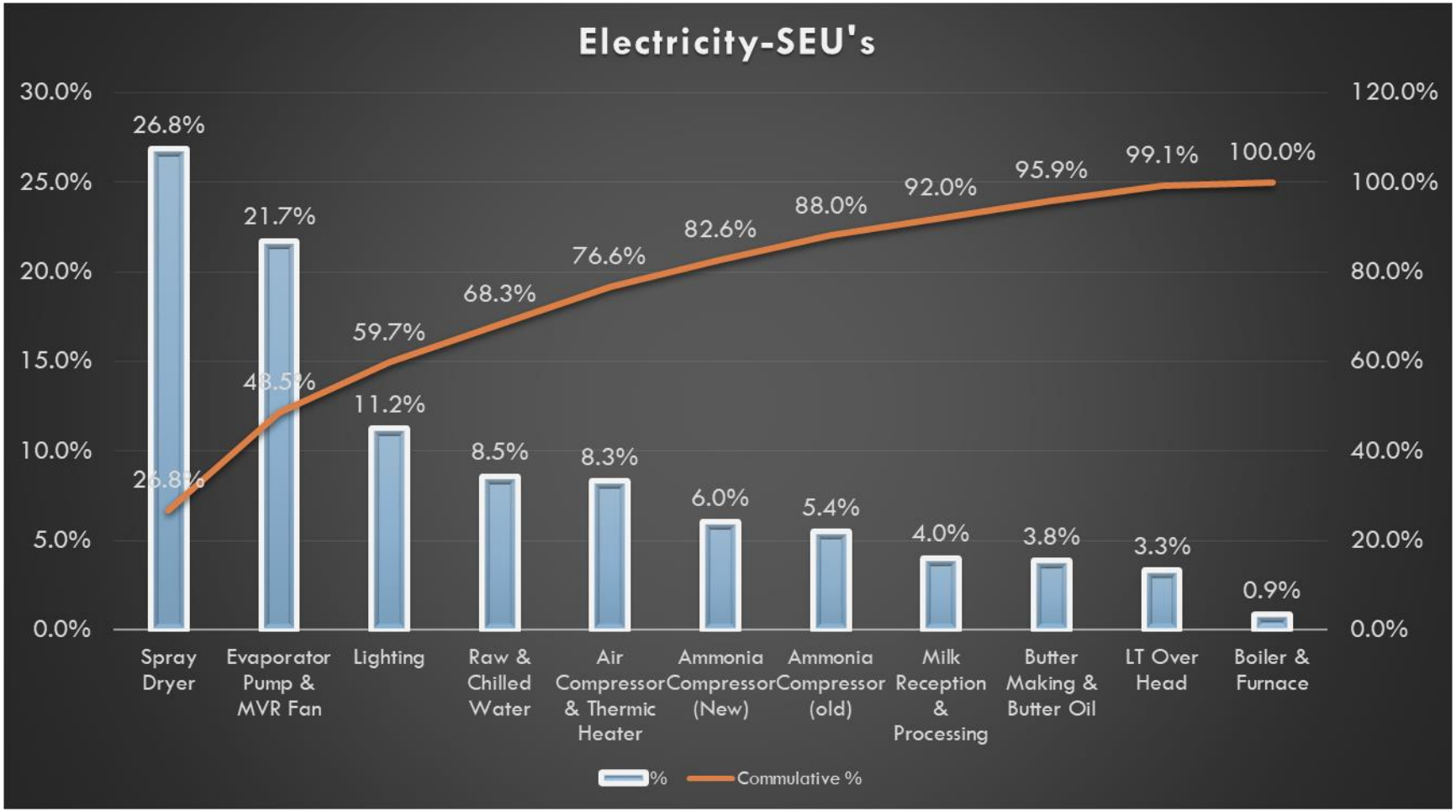
Step-7.3 : Identify & Quantify SEU's



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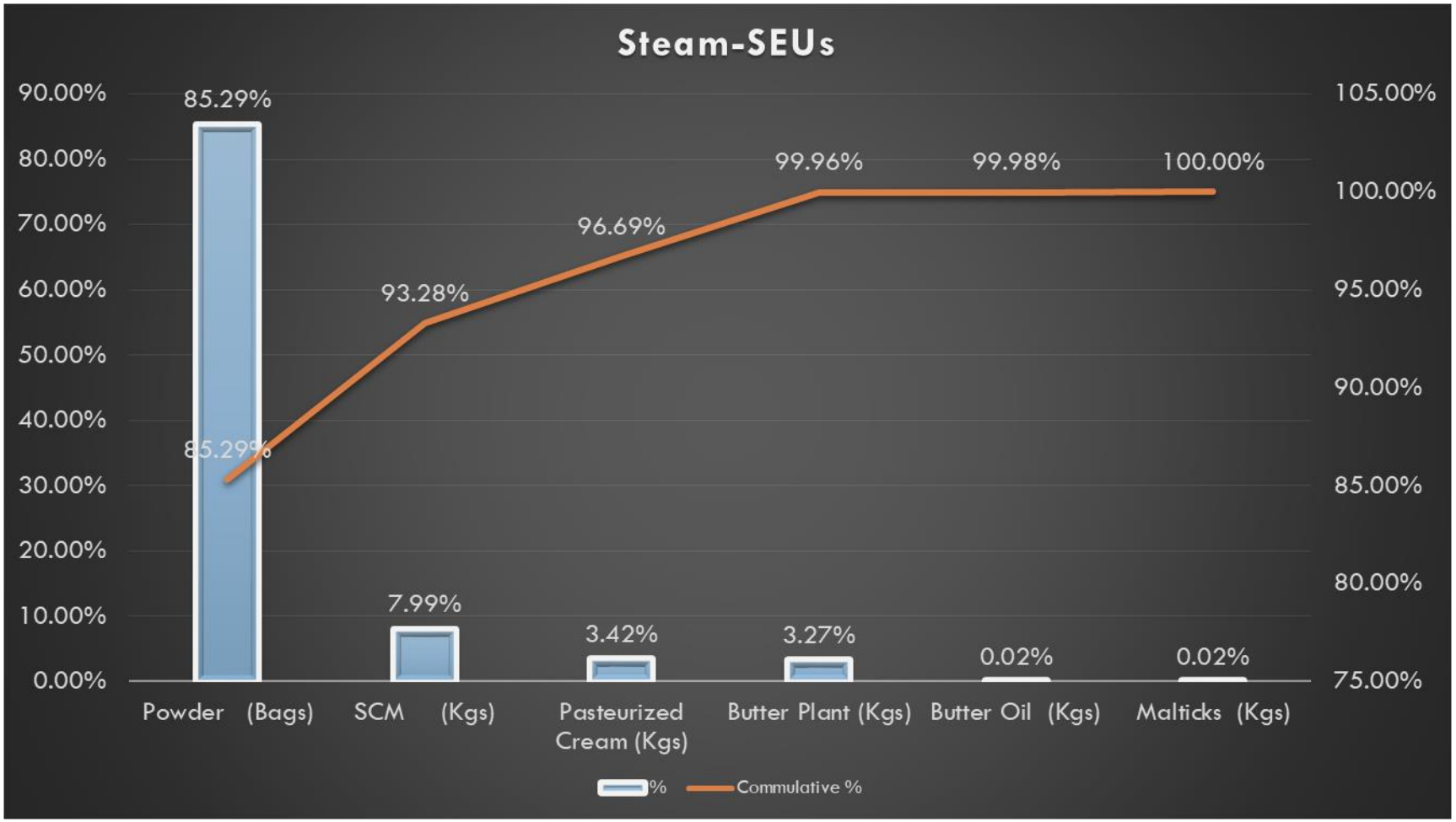
Step-7.3 : Identify & Quantify SEU's



Step-7.4 : Identify drivers, get data and analyze SEU's.

⇒ The purpose of this step is to identify, quantify and analyze drivers of SEUs. Energy consumption is affected by many variables. Data should be collected and analyzed to determine the effects of relevant variables on the SEU.

⇒ Sub metering of SEUs represents a good practice to establish the current energy performance of SEUs and track future improvement in their energy performance. The energy team should engage with appropriate operations personnel when identifying and defining the relevant variables.

⇒ Following of relevant variables that can affect SEUs

i. Weather. Including heating and cooling degree days;
ii. Production related. Such as rate. Product mix, quality, rework or output;
iii. Process parameters such as ambient temperature,
iv. Operating hours;
v. Occupancy levels;
vi. Material flows, properties and characteristics (including raw materials);
vii. Etc.

⇒ Each SEU will have its driving factors identified, quantified and analyzed.

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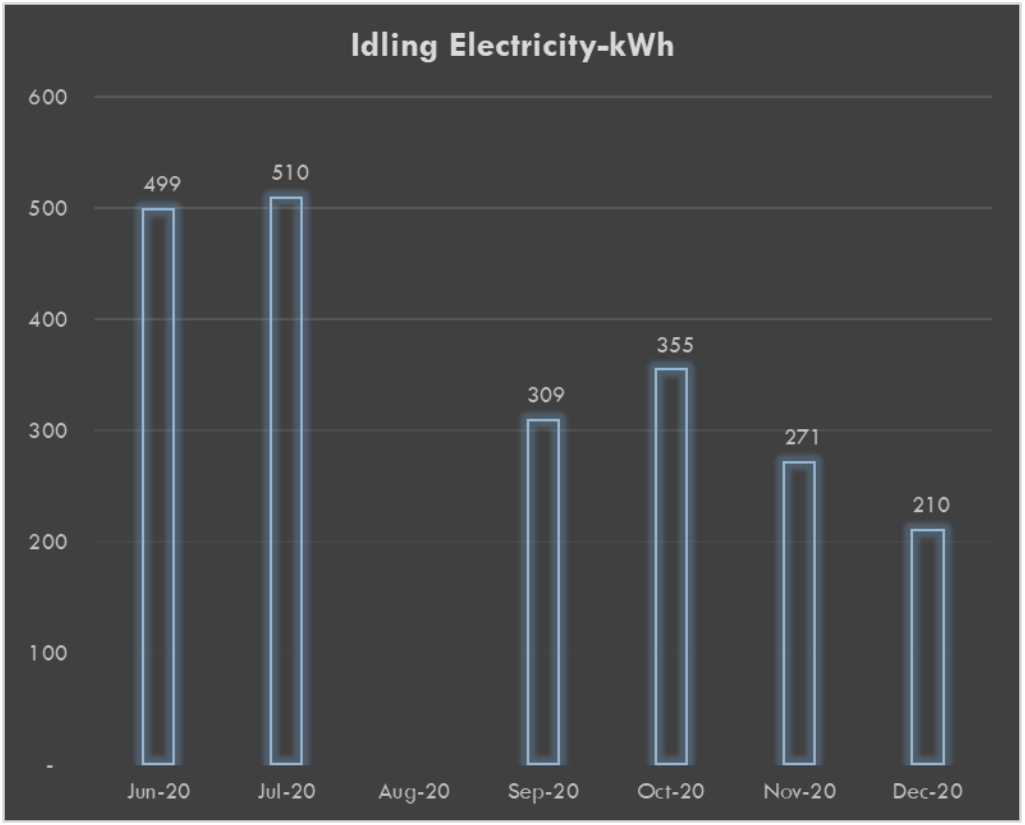
Step-7.4 : Identify drivers, get data and analyze SEU's.

Evaporator				
Month	Electricity-kWh	Removal of Water-lit	EnPI - lit./kWh	Idling Electricity-kWh
Jun-20	73,319	2,821,225	38.48	499
Jul-20	74,232	2,804,634	37.78	510
Aug-20	80,005	3,469,312	43.36	
Sep-20	77,665	3,297,266	42.46	309
Oct-20	63,120	2,791,585	44.23	355
Nov-20	56,267	2,320,464	41.24	271
Dec-20	60,199	2,653,880	44.09	210



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Step-7.5 : Develop Baselines and performance indicator for each SEU's.

⇒ The purpose of the energy baseline is to develop a starting point for measuring energy performance improvements.

⇒ The purpose of EnPI is to identify a small number of indicators of energy performance which will help you to be confident that performance targets are being met and if not to alert you of any problems at an early stage.

⇒ Baselines and EnPIs will be developed including the development of a metering plan to add any additional energy meters that may be required.

Step-7.5 : Develop Baselines and performance indicator for each SEU's

Energy Performance Indicator (EnPI)

EnPI Level		EnPI	Unit	Measured /Calculated	Source	Value	Time period	Standard practice	Jul-20	Aug-20	Sep-20
Department	Compressed Air system	Leakage rate	%	Calculated	Through Audit			within 10%		24%	
Equipment	Boiler	Coal-kg consumption per ton of steam.	kg/ton	Measured	Through Audit	126.2		115	123.7	122.3	126.8
Production department	SCM	Electrical consumption per kg of production	kWh/kg	Measured	Data Provided by Industry	0.139	Jul-19 to Jun-20		0.132	0.138	0.150
		Steam consumption per kg of production	kg/kg	Measured		1.161			1.101	1.131	1.132
	Butter Plant	Electrical consumption per kg of production	kWh/kg	Measured		0.308			0.314	0.316	0.238
		Steam consumption per kg of production	kg/kg	Measured		2.467			2.514	2.597	2.411
	Pasteurized Cream	Electrical consumption per kg of production	kWh/kg	Measured		0.171			0.182	0.168	0.168
		Steam consumption per kg of production	kg/kg	Measured		1.363			1.533	1.433	1.335

Step-7.6 : Perform Technical Energy Audit

⇒ Technical energy audits (assessments) and inspections will be carried out occasionally as required to identify additional energy saving opportunities in addition to those identified on a day to day basis.

⇒ The potential for renewable and alternative sources of energy will be considered.

⇒ Audit outputs include information on current use and performance and they provide ranked recommendations for improvement in terms of energy performance and financial benefits.

Step-7.6 : Perform Technical Energy Audit

Table ES. 1: Energy Conservation Measures in Compressed Air System.

Energy Conservation Measures	Initial Investment	Annual Benefit	Payback	Internal rate of return	%age savings
1. *Eliminate the identified compressed air leaks*	50,000	242,029	2.5 months	154%	3.7%

Table ES. 2: Energy Conservation Measures of Boiler Replacement.

Energy Conservation Measures	Initial Investment	Annual Benefit	Payback	Internal rate of return	%age savings
2. *Replace coal fired boiler with gas fired 95% efficient boiler (gas rate assumed 1500PKR/mmBtu).*	14,000,000 PKR	1,187,812 PKR/yr	11.7 years	--	1.4%
3. *Replace coal fired boiler with gas fired 95% efficient boiler (gas rate 1031 PKR/mmBtu).*	14,000,000 PKR	28,366,438 PKR/year	0.5 years	89%	32%

Step-7.6 : Perform Technical Energy Audit.

Energy Conservation Measures	Initial Investment	Annual Benefit	Payback	Internal rate of return	%age savings
5. *Reduce the percentage of oxygen in coal fired boiler from 10.7% to 3%*	1,000,000 PKR	5,094,229 PKR/year	2.5 months	154%	5.8%
6. *Reduce oxygen percentage in flue gases of gas fired boiler from 9.7% to 3%*	100,000 PKR	133,815 PKR/yr	1.3 years	--	1%

Table ES. 4: Energy Conservation Measures regarding economizers of the boilers.

Energy Conservation Measures	Initial Investment	Annual Benefit	Payback	Internal rate of return	%age savings
7. *Insulate the economizer outer surface and reduce the surface temperature to 80°C*	500,000 PKR	377,615 PKR/year	1.32 years	67%	0.43%
8. *Improve the boiler efficiency of gas fired boiler to 70% by installing*	2,000,000 PKR	646,776 PKR/yr	3.1 years	21 %	4%

Step-7.6 : Perform Technical Energy Audit

S.No.	*Energy Conservation Measures*	*Initial Investment (PKR)*	*Annual Benefit (PKR)*	*Payback*	*Internal rate of return (%)*	*%age savings of Old Motor vs IE3 Motor*
1.	Replace MVR Fan, with IE3 premium class motor	3,249,353	Rs. 2,387,272	1.4 years	60%	12%
2.	Replace Exhaust Fan Motor M4, with IE3 premium class motor	1,474,779	Rs. 1,613,354	1-years	65%	19%
3.	Replace Force Draft Fan (Drying Unit), with IE3 premium class motor	6,85,050	Rs. 1,122,478	5-months	75%	36.9%
4.	Replace High Pressure Pump with VFD (Drying+ Coal fire boiler Unit), with IE3 premium class motor	807,138	Rs. 1,131,814	5-months	75%	43%
5.	Replace Force Draft Fan with VFD (Static Fluidizer Bed), with IE3 premium class motor	280,350	Rs. 137,799	1.4-years	60%	12%

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Step-7.7 : Identify opportunities for improved performance, review and decide on action plan

⇒ Development of action plans will include ensuring that objectives and targets are met. Selection of opportunities for inclusion in action plans will include consideration of all the above items in addition to technical feasibility, legal and other requirements and financial appraisal.

⇒ In addition to the above sources of improvement opportunities, all staff and colleagues are encouraged to suggest opportunities.

⇒ Training plans will also be developed for those with the potential to influence the energy performance of the organization.

⇒ Please note that action plans are not entirely lists of technical investment projects and will include housekeeping, management and organizational activities.

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Step-7.7 : Identify opportunities for improved performance, review and decide on action plan

ENERGY AUDIT ACTION PLAN						Date	Dec 28, 2020
Implementation Team members	Mr.----------, Mr.----------, Mr.----------Mr.----------				Project Manage by	SBEEC	
REF	INTERVENTIONS & SUB ACTIVITIES	ENERGY AUDIT			STATUS/ COMMENTS	COMPLETION DATE	RESPONSIBLE PERSON
		INITIAL INVESTMENT	ANNUAL BENEFIT	PAYBACK			
1	**Compressed Air System**						
1.1	Eliminate the identified compressed air leaks	50,000 PKR	242,029 PKR	2.5 Mos.			
2	**Energy Conservation measures of Boiler Replacement**						
2.1	Replace coal fired boiler with gas fired 95% efficient boiler (Gas rate assumed 1500 PKR/MMBTU).	14,000,000 PKR	1,187,812 PKR	11.7 Yrs.			
2.2	Replace coal fired boiler with gas fired 95% efficient boiler (Gas rate assumed 1031 PKR/MMBTU).	14,000,000 PKR	28,366,438 PKR	0.5 Yrs.			
2.3	Replace the current gas fired (low efficiency) boiler with a new gas fired 95% efficient boiler.	14,000,000 PKR	1,801,634 PKR	7.8 Yrs.			
3	**Energy Conservation Measures of oxygen percentage reduction in flue gases of boilers.**						
3.1	Reduce the percentage of oxygen in coal fired boiler from 10.7% to 3%	1,000,000 PKR	5,094,229 PKR	2.5 Mos.			
3.2	Reduce oxygen percentage in flue gases of gas fired boiler from 9.7% to 3%	100,000 PKR	133,815 PKR	1.3 Yrs.			

Step-7.7 : Identify opportunities for improved performance, review and decide on action plan

S.No	Motor Details	Rated Power	Rated Efficiency Class	Yearly Operating Hours	Hours per day	VFD Installed (Yes/No)	Rewound (yes/No)	Age of Motor	Year of Manufacture	Individual Energy Meter(Y/N)	Paybback	Result (Replaced/ Not Replaced)
1	MVR Fan Motor	200	NA	5916	17	Yes	No		1997	N		
2	Exhaust Fan Motor-M4 (Dryer +Coal Fire Boiler)	75	NA	5568	16	Yes	No	NA	NA	N		
3	Force Draft Fan (Drying Unit) with VFD	37	IEC 34-1	5568	16	Yes	No	NA	NA	N		
4	High Pressure Pump with VFD (Drying + Coal fire boiler)	45	NA	5568	16	Yes	No	NA	NA	N		
5	Force Draft Fan (Static Fluidizer Bed) with VFD	15	IEC 34-1	5568	16	No	No	NA	NA	N		
6	Blower of Air Intake System (with VFD)	18.5	NA	5568	16	Yes	Yes	NA	NA	N		
7	Ammonia Compressor-I (NO-VFD)	110	IEC 34-1	2880	8	No	No		2004	Yes		
8	Raw Water Pump for SCM	22	NA	3360	14	Yes	No		1997	N		
9	Blower of Ammonia Condenser(Without VFD)	15	NA	6264	18	No	No	NA	NA	N		
10	ID Fan (Coal Fire Boiler)	55	IEC 34-1	7656	22	Yes	No	NA	NA	N		
11	Ammonia Compressor-II (NO-VFD)	132	NA	2880	8	No	No	NA	NA	Yes		

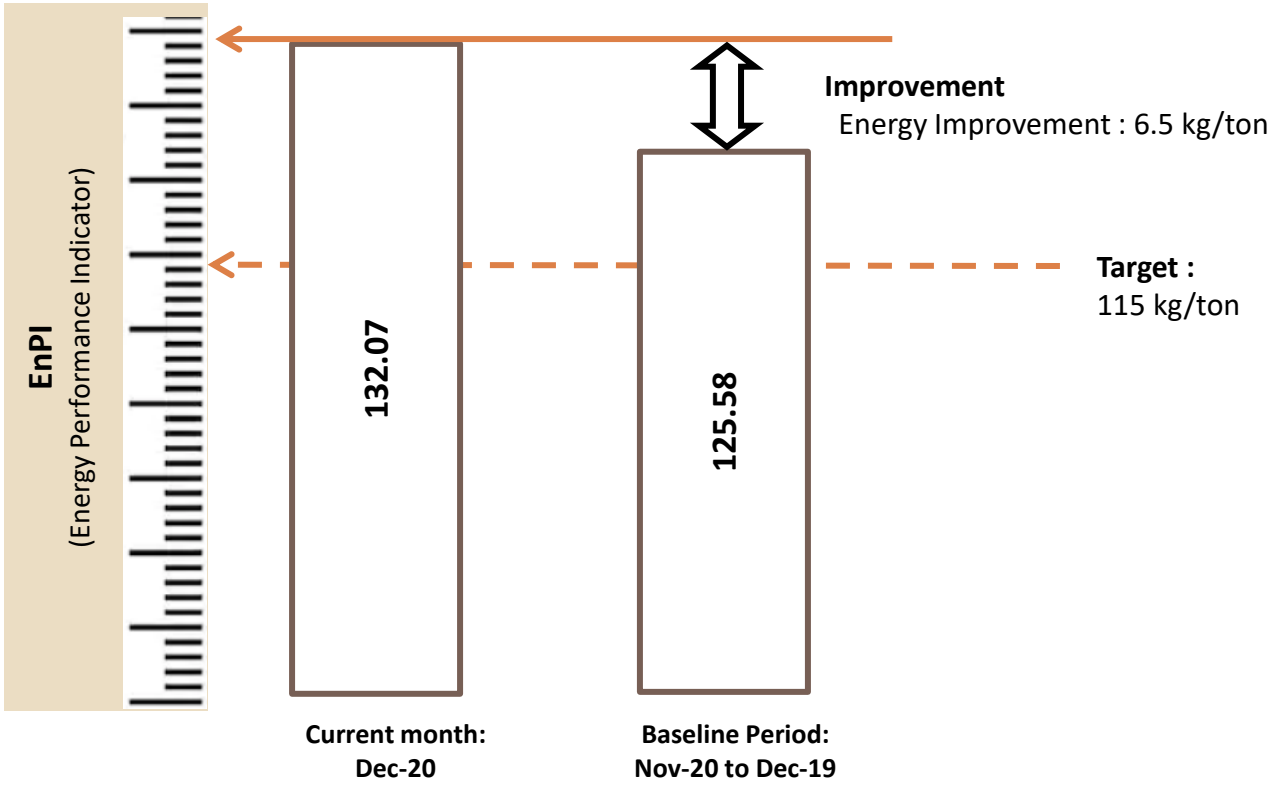
Step-7.8 : Enabling the industry to achieve ISO 50001 EnMS Certification.

⇒ From e^3 project, It helps industry to get preparation to achieve EnMS 50001 certification.

Step-7.9 : Share your successes and Repeat, for continual improvement

⇒ The first goal is to achieve 125.58 kg/ton, and once that is accomplished, the next goal is to achieve 115 kg/ton.

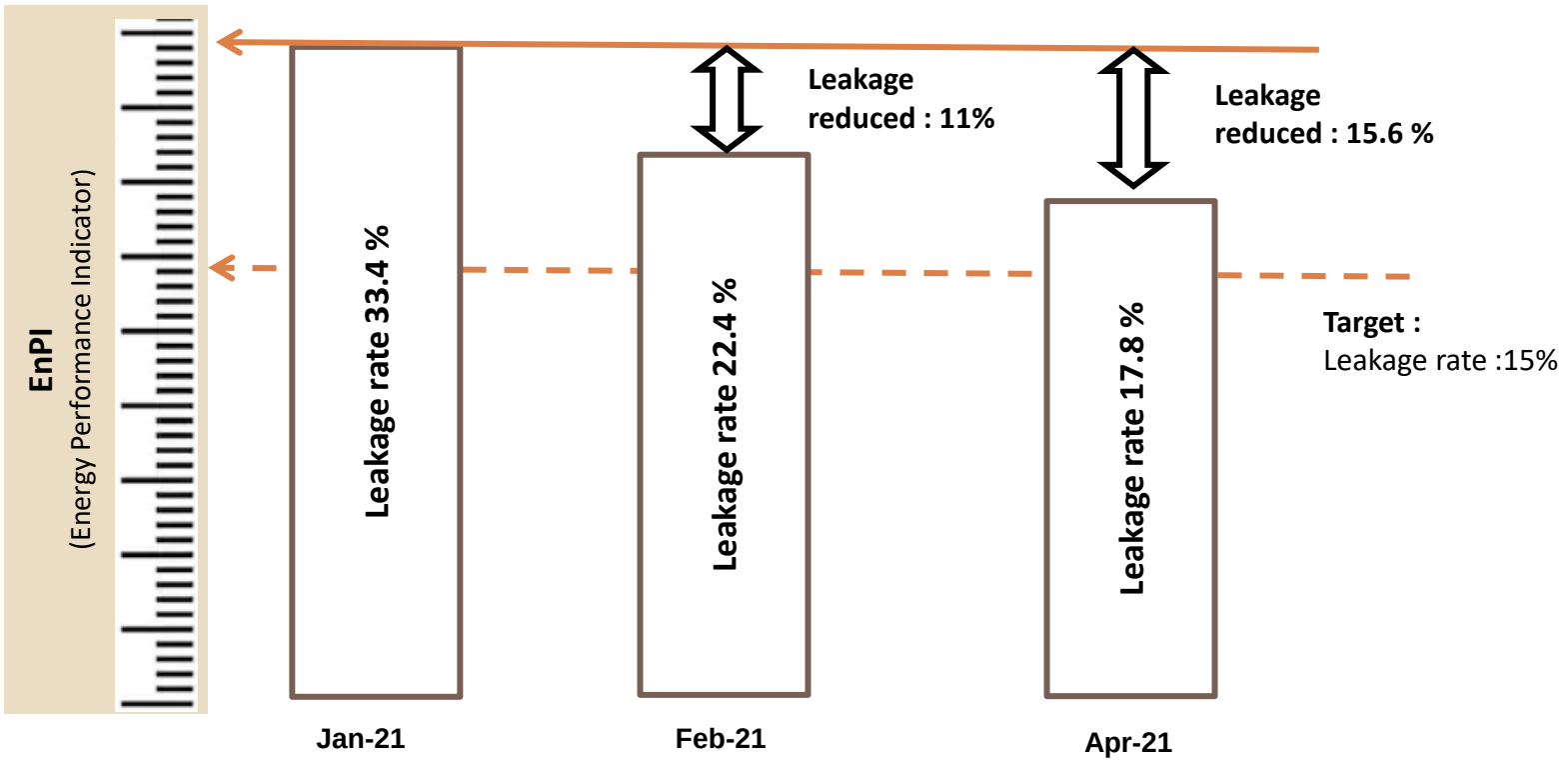
Coal-Fired Boiler



Step-7.9 : Share your successes and Repeat, for continual improvement

⇒ Industry reduced air leakages from 33.4% to 17.8%, and after achieving that goal, they set a new goal of further reducing leakages to 15%.

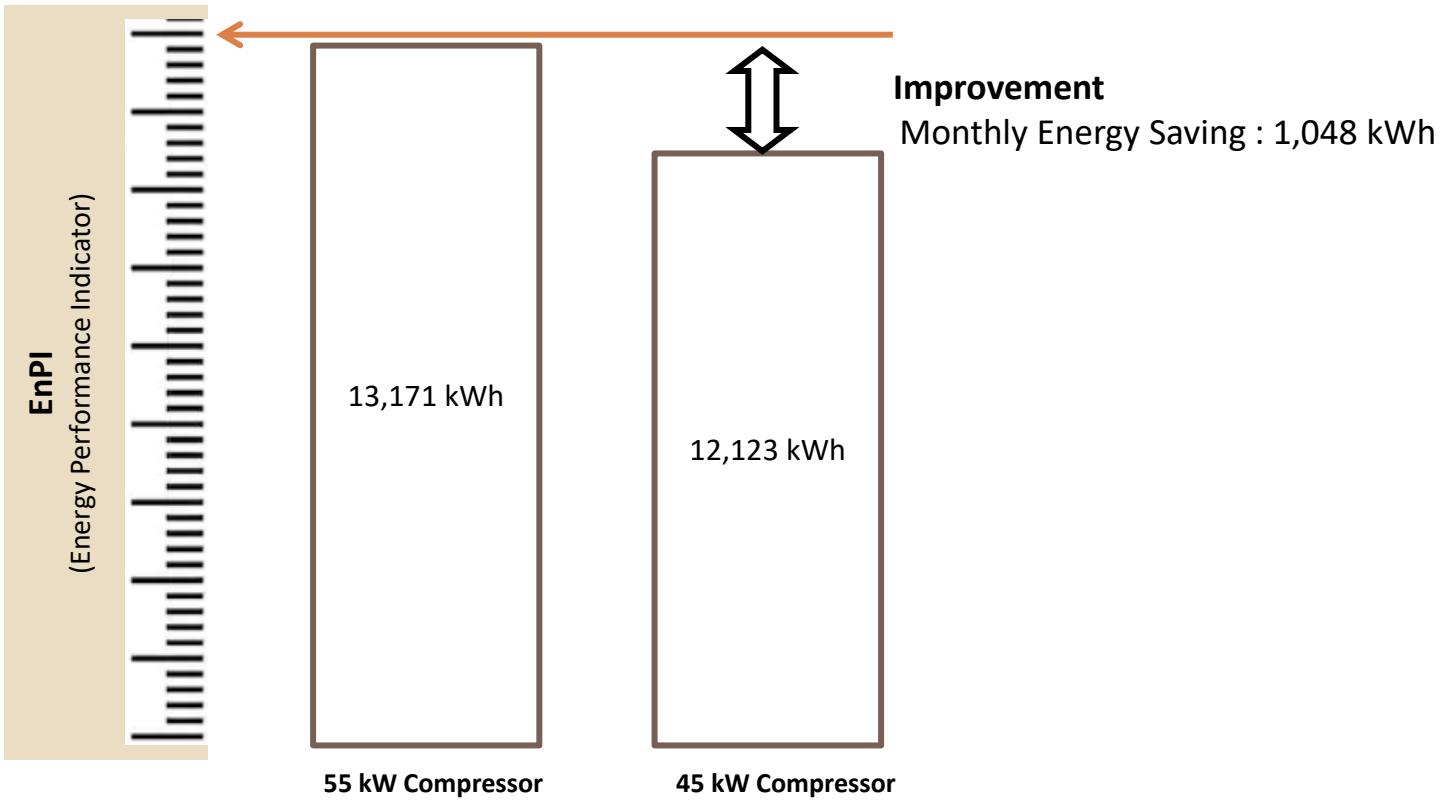
Air Compressor



Step-7.9 : Share your successes and Repeat, for continual improvement

⇒ Through using a 45kW air compressor instead of a 55kW air compressor, industry will save 1048 kWh per month..

Air Compressor



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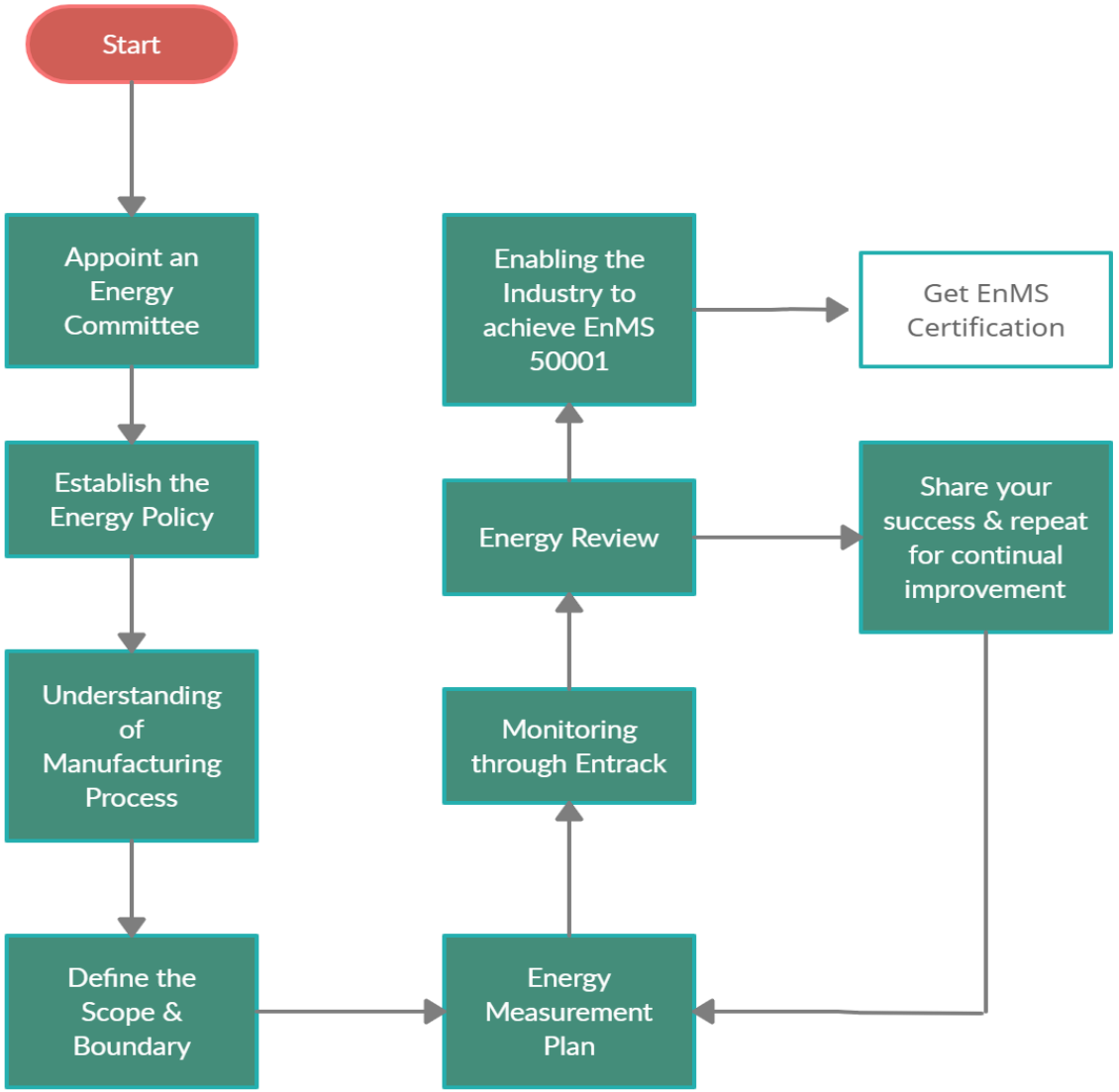
e^3 Flow Diagram



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- “It is better to save a watt than to generate a watt.”
- “The future belongs to those who prepare for it today”

THANK YOU

Always Remember: What gets measured, gets managed!


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