

Project “Accelerating energy efficiency (EE) in large industries through energy management system, system optimisation and the promotion and adoption of EE in SMEs” (IEEP)

EXPERT TRAINING PROGRAMME

ENERGY MANAGEMENT SYSTEM IN LINE WITH ISO 50001

Ha Noi, 26/02 - 01/03/2024



AGENDA

Expert Training Programme Energy Management System in line with ISO50001

26 February - 01 March 2024

Adonis Hotel - 55 Quang Trung Street, Hai Ba Trung District, Ha Noi

Day 1: 26/02/2024

Time	Contents	Speakers
8.00-8.30	Registration and welcome	
8.30-8.35	Participants Introduction	Representative of UNIDO Project Office
8.35-8.45	Opening speech	Representative of the Project Management Board
8.45-10.00	<ul style="list-style-type: none"> - Overview of the Energy Management system - 6 key concepts - Build management commitment 	International Expert
10.00-10.15	Tea break	
10.15-12.00	<ul style="list-style-type: none"> - Planning, Policy and Legal Requirements - Develop energy information and plans 	International Expert
12.00-13.30	Lunch at the Hotel	
13.30-15.00	<ul style="list-style-type: none"> - Interactive session - planning - Discussion on Planning 	International Expert
15.00-15.15	Tea break	
15.15-17.00	<ul style="list-style-type: none"> - Energy Metrics and EnPIs - Review 6 key concepts and test understanding 	International Expert

Day 2: 27/02/2024

Time	Contents	Speakers
8.00-8.30	Registration	
8.30-10.00	- Implementation and Operation - Checking	International Expert
10.00-10.15	Tea break	
10.15-12.00	- Management Review - Use of tools and online aids - Implementation Plan and Resources - Financial appraisal	International Expert
12.00-13.30	Lunch at the Hotel	
13.30-15.00	- Workshop - planning, operating and checking - Delivery of Workshop Output	International Expert
15.00-15.15	Tea break	
15.15-17.00	- Business Case for Energy Management - Next Steps	International Expert

Day 3: 28/02/2024

Time	Contents	Speakers
8.00-8.30	Registration	
8.30-8.45	Q & A	International Expert
8.45-9.45	INTRODUCTIONS - Exercise 01: Demonstrate File Share System	International Expert
9.45-10.00	- SETTING THE STAGE - Review UNIDO program objectives	International Expert
10.00-10.15	Tea break	
10.15-12.00	EXPERT TRAINING APPROACH - Exercise 02: Team Building	International Expert
12.00-13.30	Lunch at the Hotel	
13.30-14.15	CONTEXT & MANAGEMENT COMMITMENT - Exercise 03: Barriers & Countermeasures	International Expert
14.15-15.00	ROLES, RESPONSIBILITIES & AUTHORITY - Exercise 04: Responsibilities and Authority	International Expert
15.00-15.15	Tea break	
15.15-15.45	SCOPE AND BOUNDARY - HW: determine scope and boundary	International Expert
15.45-16.45	ENERGY POLICY - Exercise 05: Develop Energy Policy	International Expert
16.45-17.00	Daily Wrap-up	International Expert

Day 4: 29/02/2024

Time	Contents	Speakers
8.00-8.30	Registration	
8.30-8.45	ENERGY MANAGEMENT PLANNING PROCESS	International Expert
8.45-9.30	LEGAL AND OTHER REQUIREMENTS - Exercise 06: Legal & Other	International Expert
9.30-10.00	ENERGY REVIEW - Part 1 - Exercise 07A: Evaluate energy consumption	International Expert
10.00-10.15	Tea break	
10.15-12.00	ENERGY REVIEW - Part 2 - Exercise 07B: Energy Balance & SEUs	International Expert
12.00-13.30	Lunch at the Hotel	
13.30-15.00	ENERGY REVIEW - Part 3 - Exercise 07C: Energy Opportunities	International Expert
15.00-15.15	Tea break	
15.15-16.45	ENERGY PERFORMANCE & CALCULATING ENERGY SAVINGS - Exercise 08: Calculate Energy Savings	International Expert
16.45-17.00	Daily Wrap Up	International Expert

Day 5: 01/03/2024

Time	Contents	Speakers
8.00-8.30	Registration	
8.30-9.30	EnPIs AND BASELINE	International Expert
9.30-10.00	EnPI TOOL - Illustrate EnPI Tool use with Data Set	International Expert
10.00-10.15	Tea break	
10.15-11.30	- Exercise 09: Plant-wide EnPI Calculation	International Expert
11.30-12.00	INTRODUCTION TO DOCUMENTS	International Expert
12.00-13.30	Lunch at the Hotel	
13.30-15.00	OBJECTIVES, TARGETS & ACTION PLANS - Exercise 10: Determining Objectives and Targets	International Expert
15.00-15.15	Tea break	
15.15-15.30	MANAGEMENT REVIEW OF ENERGY PLANNING	International Expert
15.30-16.30	CHANGE MANAGEMENT - Group Discussion: changing organizational culture	International Expert
16.30-16.45	COMMUNICATIONS & NEXT STEPS	International Expert
16.45-17.00	Closing Remarks	International Expert, Representative of UNIDO Project Office

Energy Management System (EnMS) Implementation Training

UNIDO International Energy Efficiency and EnMS Training

Day 1

Based on the contents of the UNIDO Practical Guide for
Implementing and Energy management System

Delivered by: Richard Morrison, Stefan Walta

1

Welcome and Introductions

- Richard Morrison, Stefan Walta
- Name
- Organisation
- Energy Management Experience
- What do you expect to learn over this program?



2

Housekeeping

- Emergency Exits
- Toilets
- Mobile Phones
- Breaks
- Lunch
- Please restrict email to break times
- Interact and ask questions



Today

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Lunch		90	12:00	13:30
Interactive session - planning	60		13:30	14:30
Discussion on Planning	30		14:30	15:00
Break		15	15:00	15:15
Energy Metrics and EnPIs	75		15:15	16:30
Review 6 key concepts and test understanding	30		16:30	17:00
Day 1 End			17:00	

Preview of tomorrow

Topic	Duration (hours)	Break duration	Start Time	End Time
DAY 2				
Implementation and Operation	45		08:30	09:15
Checking	45		09:15	10:00
Break		15	10:00	10:15
Management Review	15		10:15	10:30
Use of tools and online aids	40		10:30	11:10
Implementation Plan and Resources	20		11:10	11:30
Financial appraisal	30		11:30	12:00
Lunch		90	12:00	13:30
Workshop - planning, operating and checking	75		13:30	14:45
Delivery of Workshop Output	15		14:45	15:00
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Business Case for Energy Management	75		15:15	16:30
Next Steps	30		16:30	17:00
Day 2 End			17:00	

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The approach to Energy Management outlined in this program can be applied to any organization regardless of size or structure

Residential, Small and Medium Sized Enterprises (SMEs),
Significant Energy Uses (SEUs), large factory, total corporation,
national level, etc..

Energy = Carbon = Money

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Purpose of the course

- Access to energy is becoming more costly and environmentally damaging
- The era of cheap energy is over (in many countries!)
- Reduce energy consumption (kWh or GJ, etc.)
 - Reduce cost
 - Reduce GHG emissions
- Role of energy efficiency
- Benefits of a systematic approach to energy management

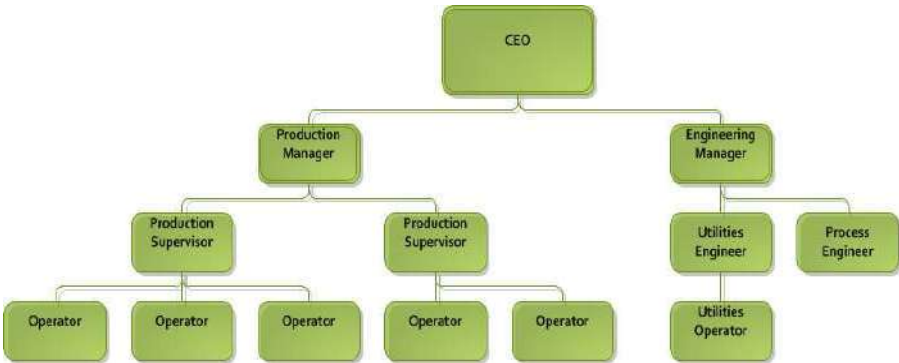
Central Message: It is not difficult to reduce energy consumption in most organisations

8

Different Priorities



9



Who in this organisation could sanction a \$100,000 purchase on behalf of your company?

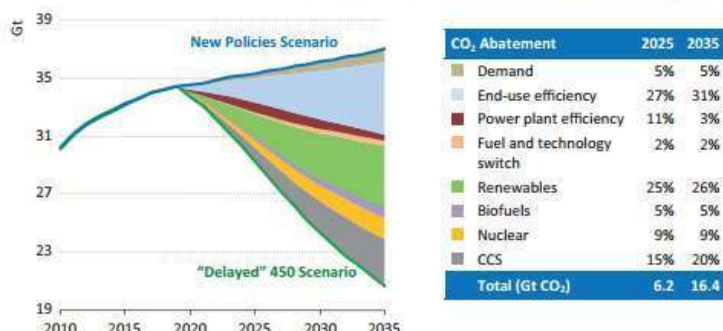
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Climate Change - What needs to be done

Figure 3.15 World energy-related CO₂ emissions abatement in a "delayed" 450 Scenario relative to the New Policies Scenario

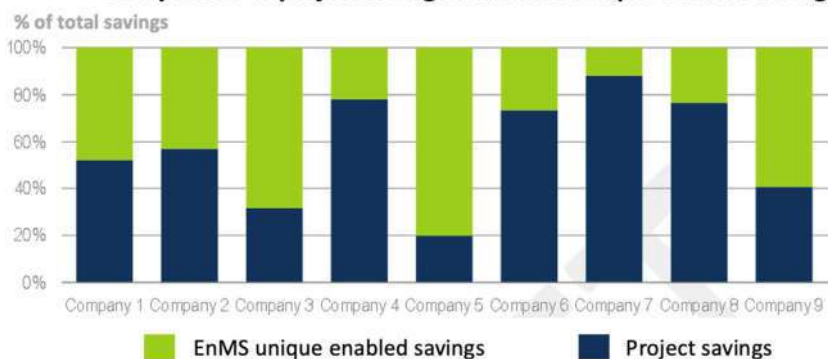


While technological progress is needed to achieve some emissions reductions, efficiency gains and deployment of existing low-carbon energy account for 41% of the required savings IEA Redrawing the Energy- Climate Map 2013

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Separation of energy savings types

Comparison of project savings and EnMS unique enabled savings



There is evidence that energy management systems unlock energy savings beyond those from technology replacement or process upgrades

Note: Companies 1-9 are medium-sized and large companies from metal processing, chemicals, automotive, construction material and power generation sectors in Egypt, North Macedonia, South Africa and Turkey

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Industrial Energy Efficiency Benefits

- Energy efficiency has demonstrated, time and again, that
 - ✓ It saves industrial firms money
 - ✓ It reduces production and product costs
 - ✓ It increase reliability of operations
 - ✓ It has a positive effect on productivity and competitiveness
 - ✓ It can offer attractive financial and economic returns
 - ✓ Reduces risk/exposure to rising energy prices
 - ✓ Increases security of supply
 - ✓ ...



Why it is not happening then?

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Barriers to Industrial Energy Efficiency

- M** • Management focus is on production & volumes, not on EE
- K** • Lack of information and understanding of own energy performance
- K** • Lack of adequate skills for identifying, assessing, developing and implementing EE measures and projects
- K** • Poor or misused monitoring systems and data
- M** • First costs more important than recurring costs → disconnection between capital and operating budgets
- M** • Staff behavior and attitude
- F** • Financing constraints

M Management/organizational barrier

K Knowledge/competency barrier

F Financial barrier

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Purpose of today's training

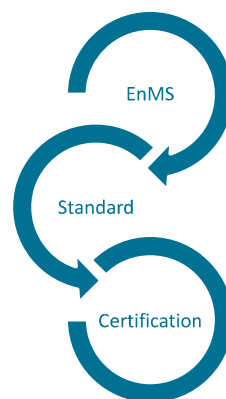
- Build enterprises' and EE consultants' understanding of:
 - ✓ Energy Management Systems in line with ISO 50001
 - ✓ Benefits of EnMS & ISO 50001, and resource requirements for implementation
- Enable enterprises to put together a high-level project management plan (time, resources, costs..) to implement EnMS
- Enable enterprises to initiate the development and implementation of an EnMS

Central Message: It is not difficult to reduce energy consumption in most organisations

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Some terms to understand

- Energy Management System (EnMS)
 - Systematic approach to the management of energy use
- Energy Management System Standard
 - Standardised approach to implementing an EnMS
 - You may decide to base your EnMS on a standard e.g. ISO 50001:2011
- Certification of EnMS
 - You may decide to have your EnMS certified to a standard
- Self-evaluation and self declaration of conformance



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Does anyone here think it is difficult to achieve savings of over 10% in energy consumption without financial investment in most facilities you know?

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Context

- Climate change
 - Intergovernmental Panel on Climate Change (IPCC) – AR6 – 20 March 2023
 - Northern summer of 2023
- Energy cost inflation
- Energy crisis from the war in Ukraine
- Pollution from fossil fuel extraction and combustion
- Decarbonisation targets
- Corporate social responsibility (CSR)

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Context of the Organisation

- Why is Energy Management important to your organisation?
- Need to understand why we implement this.
- Need to know the internal and external drivers to energy management.
- Are there legal or contractual requirements?
- Is there an expectation from investors, shareholders, state agencies or other that will influence the management system?

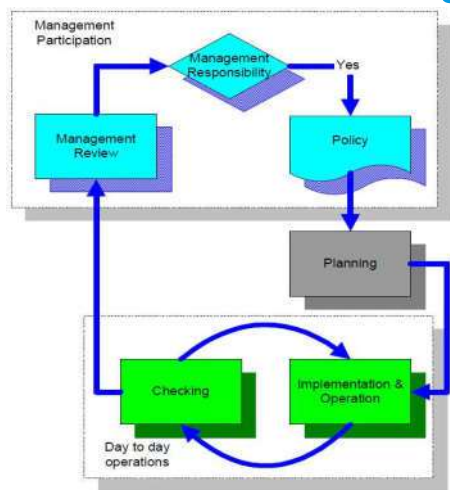
All of this will shape the development of the EnMS.

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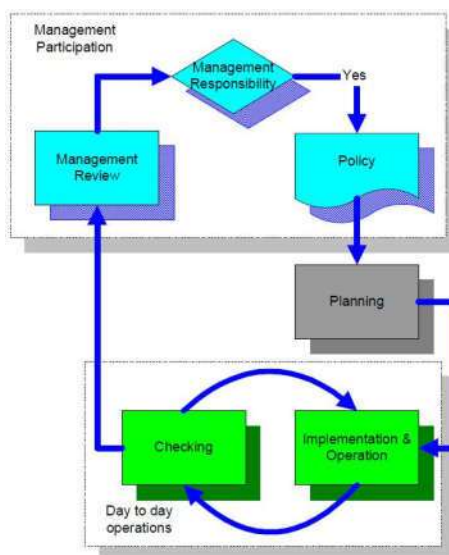
ISO 50001 Energy Management Standard



Source ISO5001:2018

Six Key Concepts

1. Commitment
 - Roles and Responsibilities
2. Significant Energy Users (SEUs)
3. Energy Performance Indicators (EnPIs)
4. Opportunities List
5. Operational Control
6. Review



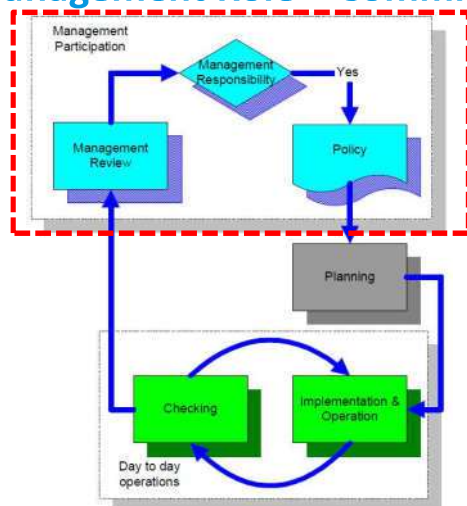
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Management Role – Commitment (Key Concept #1)



- Give commitment
- Sign policy
- Allocate resources
- Assign responsibility
- Top management representative
- Give support
- Make decisions

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This is the foundation of the system

Most managements have limited resources

- Management cannot give all of us everything we want

They need to be persuaded that this is a good idea

- Maybe they have if you are here!
- You need to show quick results to sustain their interest
 - Your efforts will reduce costs
 - This feeds directly into increasing profits
- You will improve the organisations environmental performance
 - This is very good public relations
 - Make the boss feel good
- You need to keep them convinced

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Roles, responsibility & authority

- Roles and Responsibilities are required for each individual involved in the EnMS.
- Each person needs to understand their own role and responsibilities
- Every needs to know each others authority levels
- This may seem like common sense but is often a source of ineffectiveness
- This is a key concept
- MUST be completed, accepted and communicated in advance of next steps

Roles, responsibility & authority

Practical Guide for Implementing an Energy Management System										
Energy Management System Tools										
Roles and Responsibilities										
Task	What is required?	Frequency	Relevant Documentation	Communication	Timeline		Managing Director	Energy Mgt Rep	Energy Manager	Maintenance Engineer
Preparation & Commitment										
Define scope and boundaries of the EnMS	Scope: what energy sources and uses are included Boundaries: what parts of the organisation are	Review annually	Scope worksheet	Energy Team				Lead	Participate	Inform
Manage roles and responsibilities	Ensure that relevant personnel understand their roles, responsibility and authority and are resourced and supported in their roles in the EnMS implementation	Continuously	This worksheet	All affected staff and contractors			Inform	Lead	Participate	Participate
Develop the energy policy	Develop and periodically review the energy policy document	Review annually prior to management review	Policy worksheet	As appropriate			Inform	Lead	Participate	
Review/Approve the energy policy	Review and approve the policy document	Annually	Energy Policy	All staff and contractors			Lead			
Participate in management review	Attend the management review meeting	Annually	Presentation and minutes	Energy Team and top management team						
Consider energy performance in long term planning	Ensure that energy performance is considered in long term and strategic planning	As required	Energy Strategy	Energy Team, project management team						
Set objectives and targets	Based on available opportunities but aligned with relevant commitments	Annually		Top management and energy team						

Important Roles

- We want someone at the top level of the organisation to lead the energy management activities
 - Direct the activities
 - Represent energy management at senior level
 - Gain support for energy management
 - This is the management representative
- We want someone to run the EnMS on a daily basis
 - Know it in detail
 - Coordinate its development
 - Represent it at external audits
 - This is the energy manager
- In some cases both of these roles will be the same person, in others the duties may be split

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Management Sponsor

- Implementing of the energy management system;
- Reporting to top management on the performance of the energy management system;
- Reporting to top management on the energy performance of the organisation;
- Formation of an energy management team;
- Plan and direct energy management activities;
- In a larger organisation, most of the day to day energy work may be completed by others, e.g. energy manager.

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Energy Manager

- In some organisations, this may be the same person as the management representative
- Often not a full time job;
 - For example, maintenance or engineering manager or engineer
 - Probably a technical person with energy engineering knowledge
- Role
 - Implement the EnMS
 - Owns the EnMS
 - Manages energy use
 - Acts as auditee for the EnMS
- Responsibility
 - Varies with organisation
 - Implementation
 - Energy budget
 - Reporting

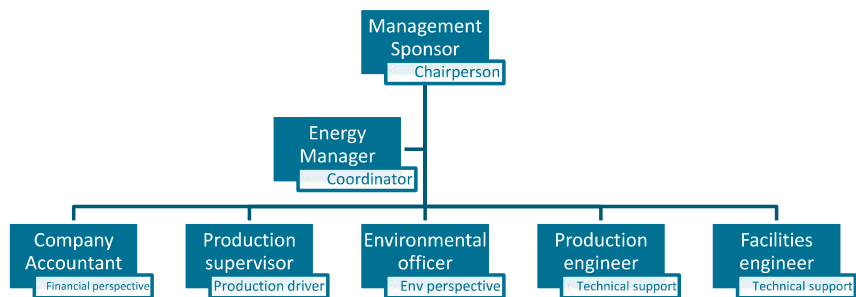
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Energy management team

- Decide structure and membership based on size and complexity of your organisation
- Representatives from relevant departments
 - Production, finance, engineering, operations, senior management representative, energy manager or engineer, etc.
- Cross functional cooperation
- Common and shared goal

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Sample energy management team (committee)



Composition will vary with organisation and culture

Size will vary

The energy manager may deputise for the management Sponsor

Teamwork

Discussion:

Why are roles and responsibilities important be established for an EnMS?

See you in 15 minutes!



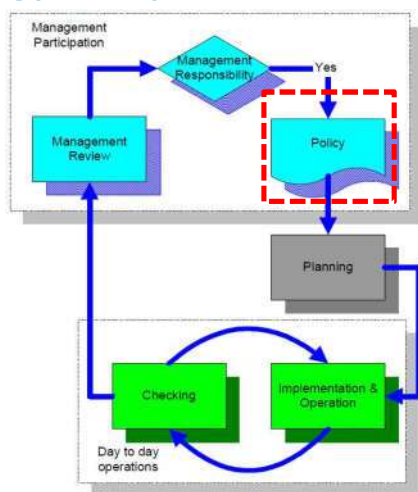
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Energy Policy



- **Management commitment**
- Not just a signature!
- Define scope of EnMS
- Appropriate to scale
- **Commitment to continual improvement**
- Make resources available
- Framework for target setting and review organizations

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Energy Policy document

- It is an official document that demonstrates support and commitment to improving energy performance
- Should not go into detail
- Scope and boundaries of the system
 - Which plant, buildings, energy sources (water?) are included
- The policy (and EnMS) should be appropriate to the nature and scale of the operations
 - Small organisation -> simple EnMS
 - Large organisation -> simple EnMS!
- Review and update regularly
 - Changes are usually minimal
- Prepare at an early stage
 - Possibly update after planning if required

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Policy should include

- Commitment to continual improvement of energy performance through the development and achievement of relevant objectives and targets.
- Commitment to provide the necessary information and resources to achieve its energy objectives and targets
- Commitment to comply with all legal and other requirements that apply to its energy using activities
- Support for the purchase of energy efficient products and services where economically feasible.
- Support the use of energy efficient design practices in new projects
- The policy should be communicated to all levels of the organisation.

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Example Policy (1)

ABCD is committed to carrying out its operations in an environmentally responsible manner, including our use of energy. We are going to continually improve our energy performance. We see a strong alignment between these activities and our goals of reducing our operating costs.

- We will achieve this improvement in energy performance through the implementation of an energy management system which includes the following:
- We will develop objectives and targets to support continuous improvement in how we use energy.
- We will make the necessary resources available to achieve these objectives and targets.

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Example Policy (2)

- We will ensure that all personnel whose activities significantly affect our energy use are adequately trained.
- We will develop measures to demonstrate our energy performance.
- We will purchase energy efficient products and services where economically feasible.
- New projects will undergo an energy review to ensure that their energy use is as low as technically and economically feasible.
- We will comply with all legal and other requirements which apply to our use of energy.
- This policy will be updated regularly to ensure that it continues to demonstrate our commitment to good energy management.
- This policy will be communicated to all employees of ABC.

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Legal and other requirements

- Probably good to review this first as it may impact later decisions
- It is part of the context
- Develop a list of all requirements that might apply to your energy use:
 - Local, national and regional laws
 - Corporate requirements, e.g. reports, plans, data, etc.
 - Management requirements, e.g. monthly performance, annual budget, etc.
 - Voluntary agreements, e.g. with energy agency or customers
 - Relevant standards e.g. ISO 50001
- Review the list for compliance at regular intervals

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Discussion:

What legal requirements are applicable to your industry from an energy perspective?

Legal Tool

Practical Guide for Implementing an Energy Management System

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Energy Management System Tools

Legal

ID	Title of requirement	Reference	Category	Date identified	Relevant (y/n)	What is affected by this requirement?	What action is required	Resp	Reqd date	How often will this be reviewed	Does it require further action?
1	Quarterly corporate energy report		Corporate	1/1/2011	y	All energy data	Generate and deliver	JB	Quarterly	Quarterly	N
2	Annual energy agency carbon accounts		Legal	1/1/2011	y	All specified carbon emissions		JB			N
3	Boiler emission licence limits		Legal	1/1/2011	y	Steam boilers	Monitor and report	AN	continuous	Continuous	N
4	Annual energy budget		Corporate	1/1/2011	y	all purchased energies	Estimate usage and cost	JB	11/1/2011		N
5	Emissions trading reporting	EU2012/123	Legal								
6											

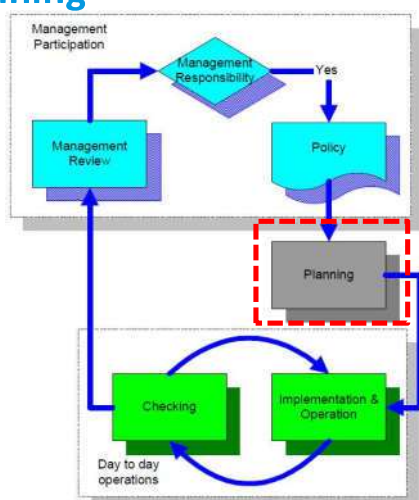
Planning

What are you going to do?

Translating the commitment and energy policy into objectives, targets and action plans

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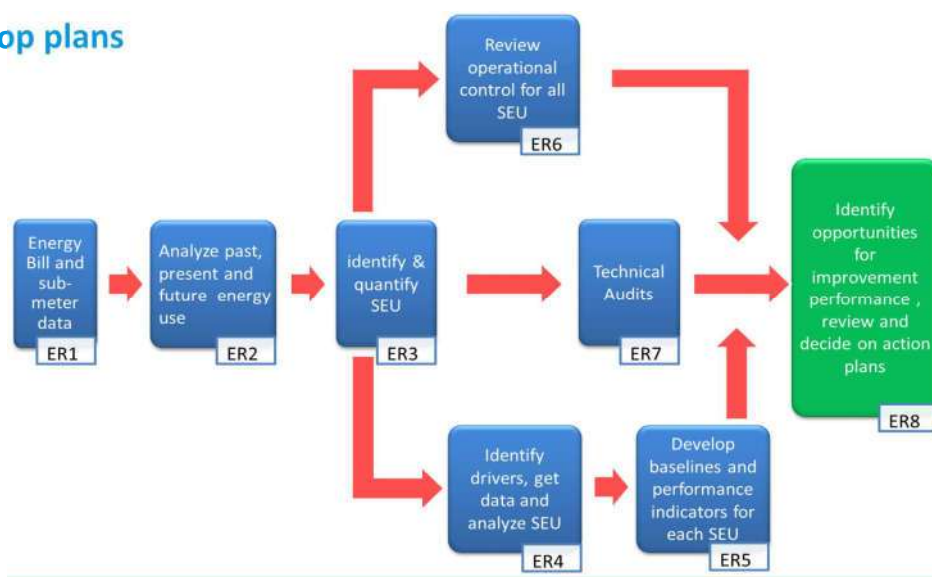
Planning



- How much energy am I using?
- Where am I using it?
- **Which are significant users?**
- What is driving it?
- Who is influencing its use?
- Do I need to have an energy audit?
 - If yes, focus it
- System Optimization
- Renewable energy options
- Are there legal or other requirements?
- Develop baseline & indicators
- Set objectives and targets
- **Action Plan**

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Develop plans



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How much energy am I using?

- How many people here know how much energy their organisation used in the 12 months ending last month?
- How much did it cost?
- How much did you use last year?
- How much are you going to use next year?
- How are you performing against your budget?
 - Why are there deviations?
- Are you using too much energy?
 - If so, how much should you be using?

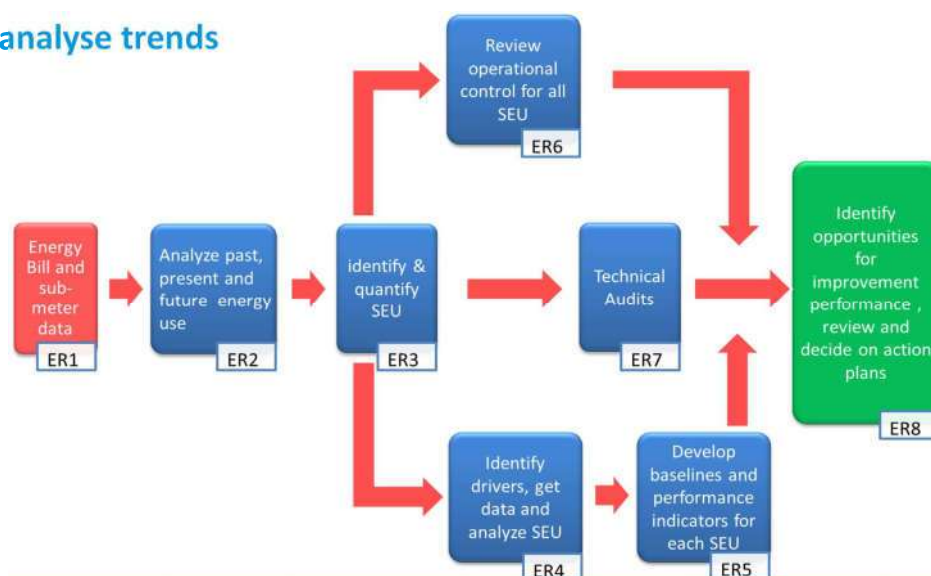
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Acquire bills and sub-meter data

- Review the data you already have:
 - Bills include both energy consumption, cost and other parameters
- You may have sub-meters
 - Manually or automatically read

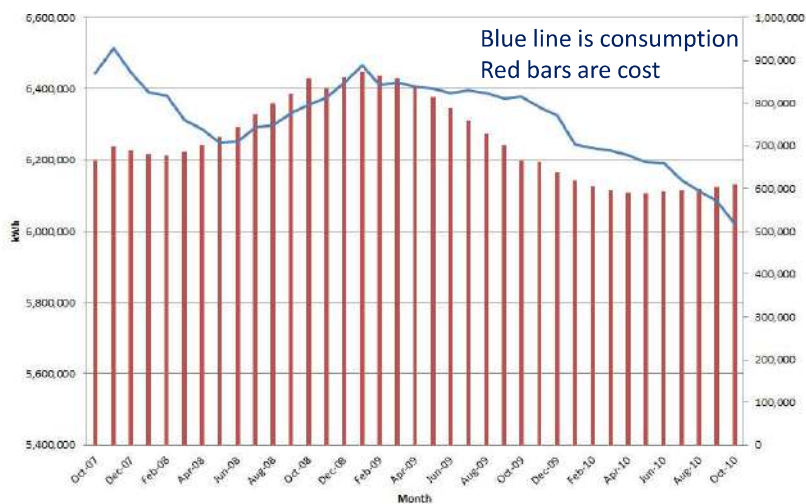
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ER2 – analyse trends



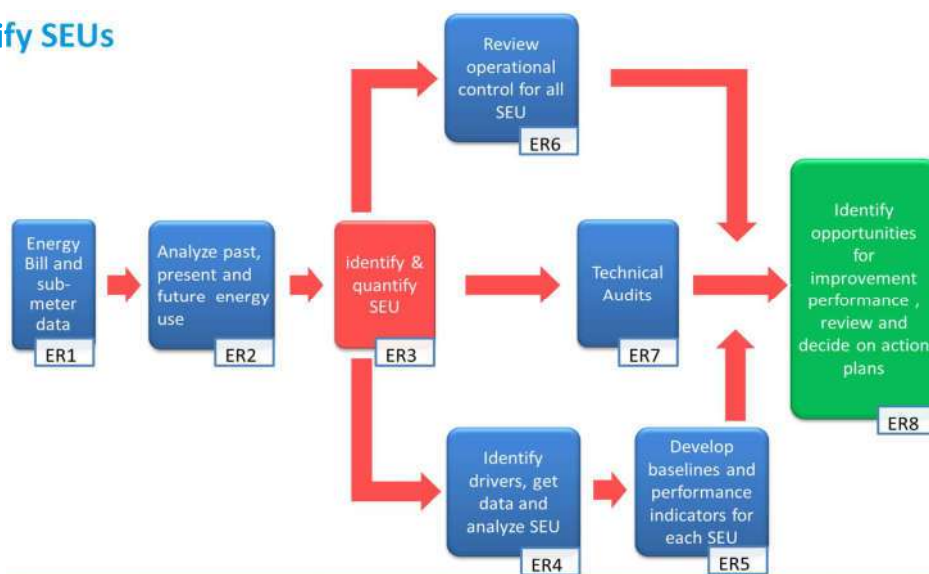
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Actual annualised electricity usage and costs



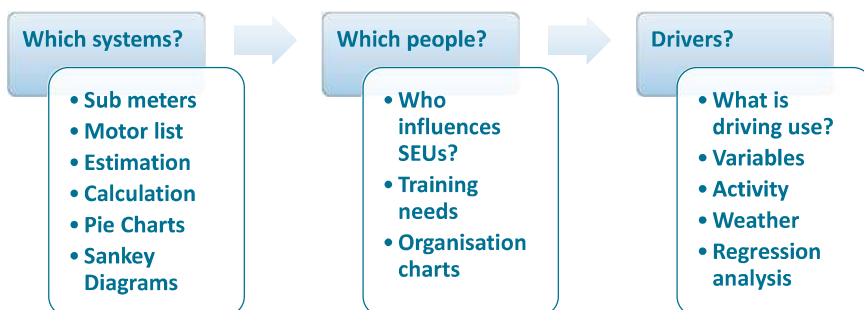
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Quantify SEUs



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Significant energy users (Key concept #2)



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Which systems?

- What is the single largest energy user in your organisation?
- How much energy does it use?
- What drives that use?
 - What causes it to increase or decrease?
- Which people affect the energy use of that item/system?

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How to quantify each energy user

- Do you have 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, flow rate, etc.
 - These can be read manually and calculated/estimated
 - Care with time of readings
- Quantification or estimation of use
 - Motor List
 - Heat Balance

SEU Motors

Energy Management System Tools													
SEU - Motors													
ID	Purpose	Name plate (kW)	Hours per year	Ave VSD speed (100% if fixed)	% name plate load	Actual Power (kW)	Annual Power (kWh)	Note	When can this be switched off?	% of total			
1	Cooling Water Pump #1	20	4200	0.5	0.9	4.5	18,900	shares load with #2		0.0189	sc	Hi	
2	Cooling Water Pump #2	20	4200	1	0.9	18	75,600			0.0756	sc	Hi	
3	Hydraulic pack drive	100	250	1	0.9	90	22,500	used intermittently		0.0225	sc	Hi	
4	Seal cooler pump	1	8400	1	0.9	0.9	7,560		almost always	0.00756	sc	re	
5	AHU 1 Fan	10	8400	0.8	0.9	5.76	48,384		night and weekend	0.048384	sc	re	
6				1	0.9	0	-			0			
7				1	0.9	0	-			0			
8				1	0.9	0	-			0			
9				1	0.9	0	-						
Total							172,944			17%			
Total electricity consumption							1,000,000	kWh per year					

What is the second largest user?

- We need to know the answers to the previous questions for all significant users (SEUs)
- Ideally we keep working on the list until we know where at least 80% of our energy is going
- **This list of SEUs will be the basis of most of the rest of our system**
- Remember that an SEU can be either a large user or one with good performance improvement potential.

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Heat balance

- Use what you know:
 - Steam flow
 - Feedwater flow (= steam flow approximately)
 - Fuel flow (heat flow = fuel flow * efficiency)
 - Gas bills
 - Hot water flow and temperature difference (ΔT) ($Q = m \cdot C_p \cdot \Delta T$)
- Build up a balance
 - Heat in = heat out
 - If you have a significant gap, you may need to measure it
 - Ultrasonic flow meters, portable heat meters
- More challenging than electrical power
 - Typically fewer measuring points

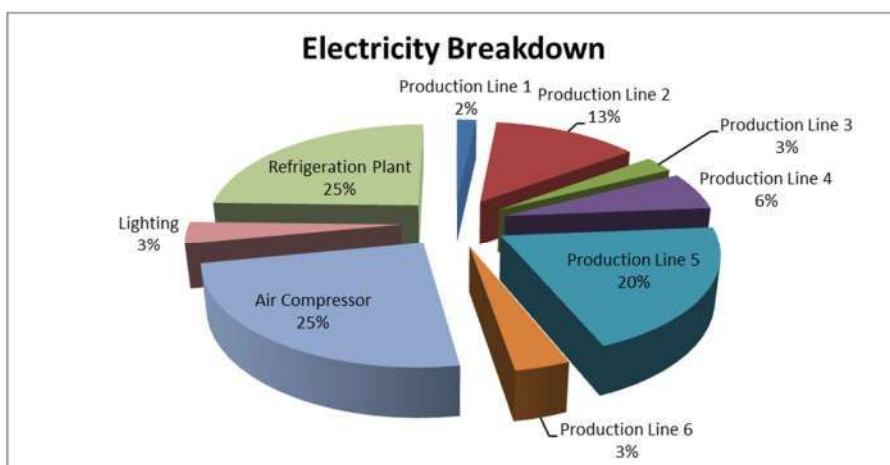
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SEU Heat Users

Energy Management System Tools											
SEU - Heat Users											
ID	Purpose	Design (kW)	Hours per year	% of design	Actual Power (kW)	Annual Energy (kWh)	% of total	Notes	When can this be switched off?	How was this estimated?	Opportunities for improvement
1	Process 1	100	4000	0.5	50.00	200,000	25%		Analyse when it can be switched off	position of control valve and design data	
2	Process 2	80	2000	0.7	56.00	112,000	14%		Analyse when it can be switched off	position of control valve and design data	
3	Building 1 heating	120	2080	0.6	72.00	149,760	19%				
4	Building 2 heating	50	2080	0.6	30.00	62,400	8%				
5					-	-	0%				
6					-	-	0%				
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What Are the SEUs

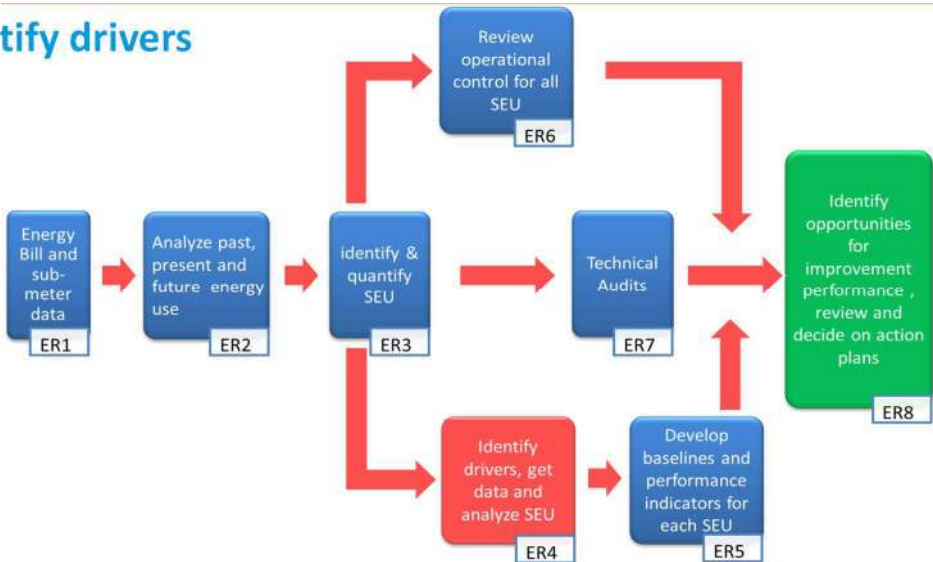


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Discussion:

What difficulties do you see in establishing the Significant Energy Users in your factory?

Quantify drivers



Establish energy variables

- Terminology: drivers, driving factors, variables, energy factors, etc.

Can anyone give an example of energy use that does not vary and is not influenced by a variable?

- Each energy use should vary based on some factor(s)
 - What is it?
 - How do they interact

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What is driving this use?

- Top level electricity and fuel
- Each SEU driver
- If you cannot quantify a variable is there a **real** reason
 - There rarely is a legitimate reason
 - Maybe you are simply out of control
- There are often indicators of significant savings from this step
 - Anomalies
 - Demonstrate with examples
- See tool Drivers

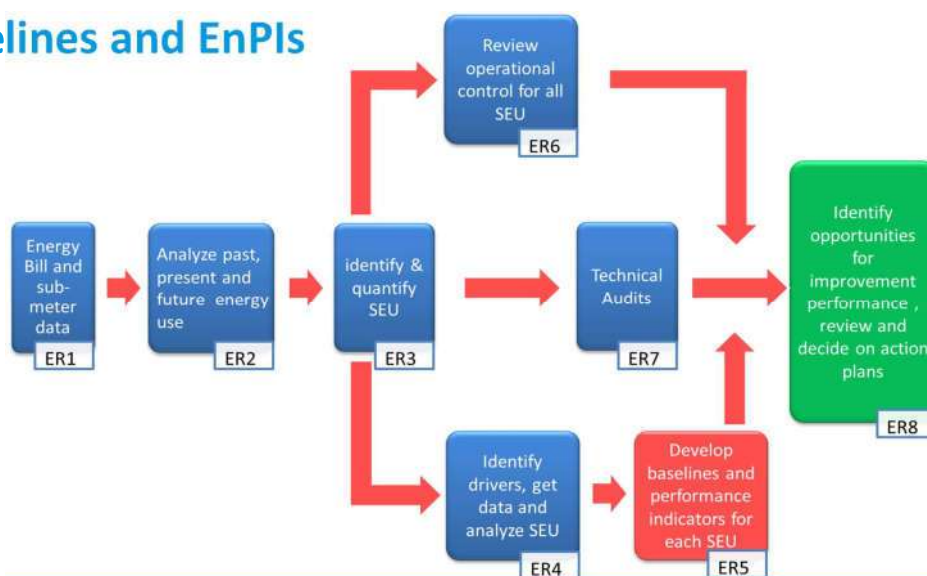
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Type of Energy Metrics

- Consider the drivers for each SEU
- Energy Performance Indicators (EnPI)
- Monthly kWh usage charts
- Baseline
- Baseload
- Regression Analysis
- CUSUM
- Etc...

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Baselines and EnPIs



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Establish energy performance indicators (EnPIs)

- Varying levels of complexity
- Absolute energy consumption
 - Simple but ignores activity levels
- Simple Ratios
 - Easy to use but can be misleading
 - Take account of activity levels
 - Can only deal with single variables
- Regression analysis
 - More complex
 - Quantifies driver effects
 - Allows comparison of actual against expected use
- Try to have an EnPI for each SEU
- Tool EnPIs

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Measurement Plan

- Once SEUs are known
 - Including variables
- Reporting requirements can be specified
- What meters and measurements are required to deliver these reports?
- How much can be achieved with existing instruments?
- Manual vs. automated
- List what new instruments are required
 - Each new instrument should be able to justify its cost
 - Don't forget installation cost
 - Electricity and liquid flow meters can be good value
 - Gas flow meters tend to be expensive (steam, compressed air, etc)

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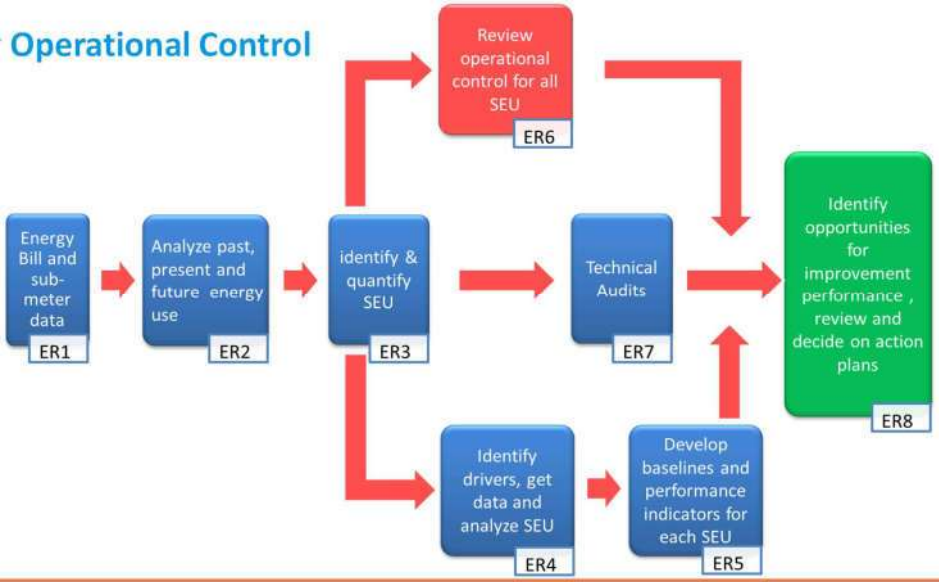
Sample measurement plan

SEU	Ideal Measurement	Existing Instrumentation	Requirement	Justification	Target Date
Refrig	Flow rate, supply and return temp, electrical load	Supply and return temp, electrical load	Chilled Water Flow meter	To calculate COP	TBD
Compressed Air flow etc....	Electrical load and compressed air	Site Compressed Air flowmeter	Electrical meter	For Specific Energy Consumption Calcs	01/01/2012

Also include instruments which measure critical operating parameters (Discussed later)

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Review Operational Control



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Review Operation control

- This is aligned with the review of training needs
 - It additionally checks operating and maintenance procedures
- Check operating procedures
- Are operators familiar with the energy impact of operations?
- Check maintenance procedures
- Check maintenance frequencies
- Are maintenance staff familiar with the energy impact of their work?
- This review will help to assess training needs

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Types of people who impact energy cons

- Immediate and direct impact
 - SEU Operators
 - Maintenance and external service personnel
- Influencers
 - Managers, supervisors, leaders
- Production people
- People who see things differently
 - Cleaners
 - Security
 - Safety Officers

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Discussion:

Who are the people that can significantly affect energy consumption in your facility?

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Training Matrix

- Make a list of all people who need to be trained
- Make a list of potential training materials/courses
- Develop a training matrix
 - Who does what and when
 - Use it also to record completion of each course
 - If your organisation already has a training tracking system, use it.
- Develop training materials
- If external help is required identify potential training service providers

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Training matrix

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Critical operating parameters

- Each SEU has operating parameters which affect its energy use
- These need to be identified, quantified, recorded and communicated, monitored and controlled
- Boiler examples:
 - Pressure, Total dissolved solids (TDS), stack temperature (variable), stack O2, condensate return rate, feedwater tank temperature
- Refrigeration examples:
 - Delivery temperature, condensing temperature (temperature lift), evaporator and condenser approach temperatures,
- Compressed air
 - Pressure, dryness, pressure drops

Critical operating parameters

Energy Management System Tools										
Critical Operating Parameters										
SEU (Inc use)	Parameter	Eng Units	Normal set point or value	Upper limit	Lower limit	Measuring Instrument Designation	Calibration Frequency	Who needs to be informed of these values?	Who needs to be informed of deviations?	Note
Steam system	Total Dissolved Solids	ppm	3500	3800	3400	TDS001	3 months	operators	supervisor	
Steam system	Boiler Pressure	bar	9.5	10	9	PT123	12 months	operators	supervisor	
Steam system	Exhaust Oxygen	% O2	3	3.5	2	Portable 123	6 months	operators	supervisor	
Steam system	Stack Temperature	DegC	N.A.	300	N.A.	TT124	12 months	operators	supervisor	Varies with firing rate
Pump 28	Differential pressure	bar	3	3.3	2.7	P28	24 months	Refrigeration	supervisor	
Refrigeration	Temperature Lift	DegC	25+/-10	35	15	T12 and T16	12 months	operators	supervisor	varies with the ambient wet bulb temperature
Refrigeration	Condenser approach temperature	DegC	5	6	N.A.	T12	12 months	operators	supervisor	

Critical Maintenance parameters

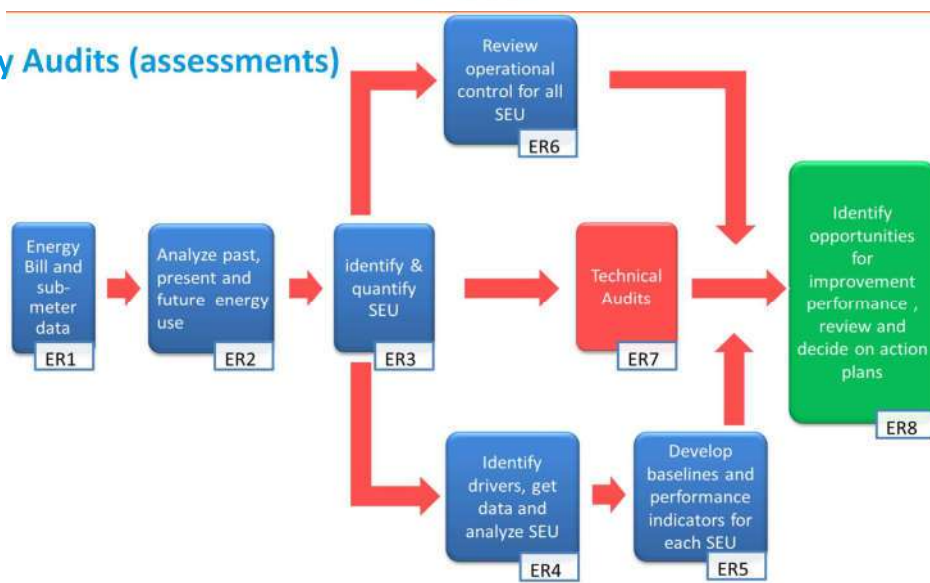
- Each SEU has maintenance activities which affect its energy use
- These need to be identified, planned, communicated, monitored and checked
- Boiler examples:
 - Blow down, TDS calibration, stream trap maintenance etc.
- Refrigeration examples:
 - Heat exchanger cleaning, temperature probe calibrations etc.
- Compressed air
 - Leaks, moisture traps driers etc.

Simplified Maintenance criteria

Practical Guide for Implementing an Energy Management System				
Energy Management System Tools				
Maintenance Criteria				
SEU (Inc use)	Task	Frequency	Who needs to be informed?	Note
Steam system	Statutory inspection	12 monthly		
Steam system	Combustion testing	6 monthly		
Steam system	Chemical treatment testing	weekly		
Compressed air	filter replacement	6 monthly		

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Energy Audits (assessments)



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Technical audit focused on the SEU's

Complete this if there are no known opportunities for improvement

- Examine the whole system and not individual components
- Establish user requirements and specification
- Examine opportunities with use
- Examine opportunities with distribution
- Examine opportunities with generation last.

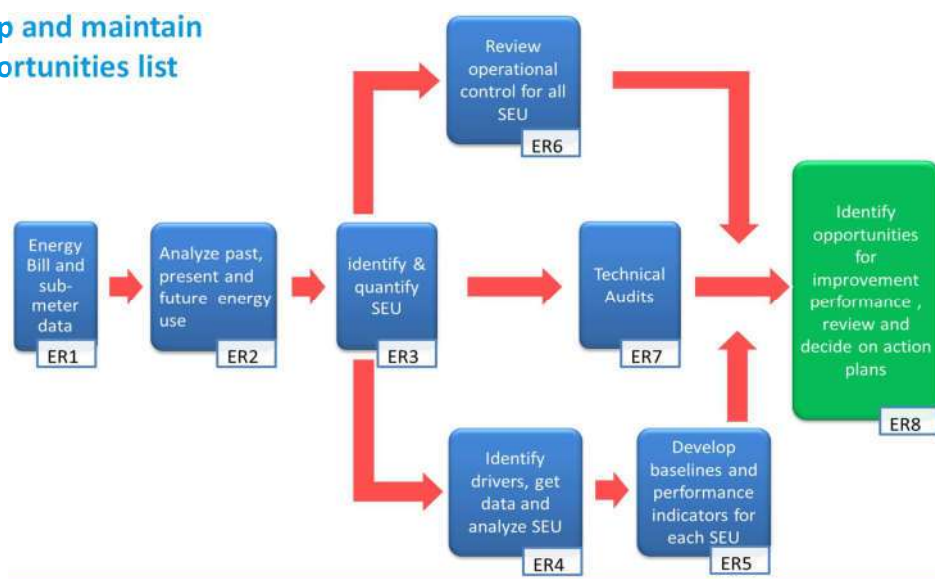
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Examine potential for renewables and alternative energy sources

- Which renewable sources are available?
 - Solar (thermal or photovoltaic)
 - Wind power
 - Biomass
- Which renewable technologies are economical with these resources?
- Which alternative energy sources are available?
 - Waste heat recovery
 - Fuel switching
- Which might be economical?
 - Cogeneration (Combined Heat and Power (CHP))

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Develop and maintain an opportunities list



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Opportunity List (Key concept #5)

- Develop a list of all potential ideas
- Select items for implementation
 - Prioritisation based on criteria
- Plan and manage their implementation
- Note: the name of this list doesn't matter alternatives include:
 - Savings Register
 - Opportunities list
 - ECO Register

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Opportunity List

Energy Management System Tools													
Opportunities List													
ID	Description of Opportunity	Service	Investment Class	Capital Cost	Potential payback (years)	Estimated Savings				Person Responsible	Target Completion Date	Status	Notes
						kWh elec	kWh fuel	CO2	Financial				
1	Fit VSD to boiler fan	Steam	Low	5000	1.43	3500				JB	4/1/2011	Approved	need set to commit
2	Replace lights in warehouse	Lighting	Med	3000	2.00	1500				KL	5/1/2011	Idea	waiting
3	Train operators in refrigeration efficiency	Mgmt	Low	1000	0.10	10000				JB	12/1/2011	In progress	
4	Reduce chiller condensing pressure	Refrig	No	0	-	4500				JB	2/1/2011	Idea	are there
5	Train cleaners in energy vigilance	Mgmt	Low	300	0.30	1000				JB	3/1/2011	Idea	prepare
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Which opportunities to implement?



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Relationship



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Targets and action plans

- You need to express your overall targets as savings in kWh (or GJ) per year
- Your action plan savings (kWh or GJ) should equal or exceed your targets
- Your EnPIs should be able to show progress or alert to lack of progress
- Consideration could be given to CO₂ reductions

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Sample Action Plan

- **Objective:**
Reduce Electric Intensity in Production area 3% from baseline (Mar - Dec 2022) by Dec 2024
- **Target:**
Reduce Electric Intensity in SP and PMs area from 500 kWh/TP to 485 kWh/TP by Dec 2024

SEU	Target Savings (kWh)	Action Plan (kWh)	Expected completion date	Who
Pump PM#1	33.600	Stop dry line vacuum pump operation, parallel with the other vacuum pump	Apr-24	
Pump PM#2	3.360	Standardize Vacuum Pump Operation	Jun-24	
Pump PM#3	3.360	Standardize Vacuum Pump Operation	Jun-24	
Agitator Chest SP	27.216	Reduce Broke Chest level from 90% to 70%	May-24	
Agitator Pulper SP	56.700	Standardize Agitating time	May-24	
Refiner SP	18.144	Standardize Refining Operation (Pressure, Consistency)	Jun-24	
Grand Total	142.380			

Measurement and Verification (M&V)

- Need to verify savings for various stakeholders such as:
 - senior management
 - external auditors
 - ESCO
- Purpose of M&V is to demonstrate that you actually made the savings?
 - Must take account of driving factors
 - Can be applied to individual action plan items or facility wide
- The level of M&V depends on project scale and complexity.
- Savings can also be confirmed using EnPIs and baseline comparisons

Discussion:

**Do you need an action plan for all
significant energy users?**

91

See you in 45 min 😊

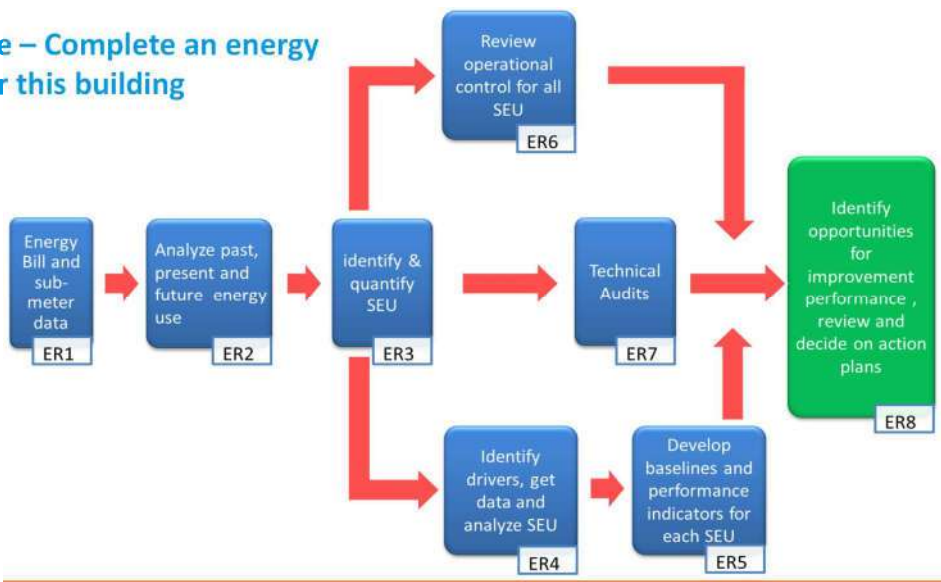


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Today

Topic	Duration (mins)	Break duration	Start Time	End Time
Registration		30	08:00	08:30
Introductions	15		08:30	08:45
Why are we here?	15		08:45	09:00
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Break		15	10:00	10:15
Planning, Policy and Legal Requirements	30		10:15	10:45
Develop energy information and plans	75		10:45	12:00
Lunch		90	12:00	13:30
Interactive session - planning	60		13:30	14:30
Discussion on Planning	30		14:30	15:00
Break		15	15:00	15:15
Energy Metrics and EnPIs	75		15:15	16:30
Review 6 key concepts and test understanding	30		16:30	17:00
Day 1 End			17:00	

Exercise – Complete an energy plan for this building



See you in 15 minutes!



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Purpose of energy metrics

- Objective support for decision making
 - Often subjective reasons
- We need to know how much energy we are using
- We need to know if performance is improving or not
- We need to know if we are meeting targets
- We need to be able to verify savings of improvements
- We need to establish the following:
 - Baseline
 - Baseload
 - Performance indicators (EnPIs)
- Numerical basis

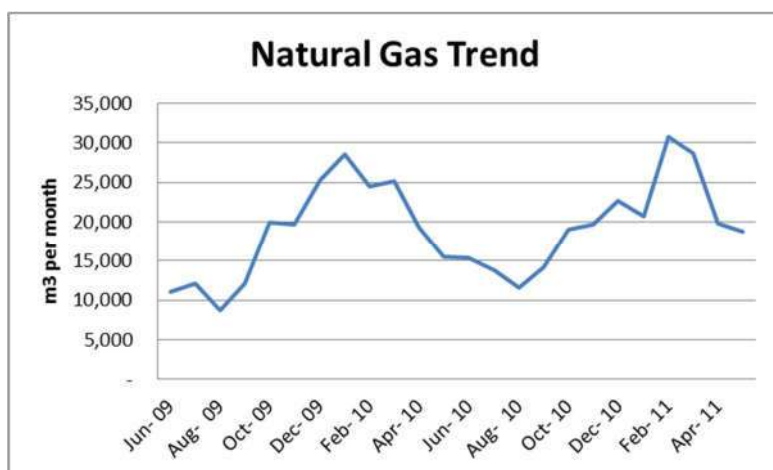
97

Energy Metrics

- Various levels of complexity
- Simple:
 - Simple: consumption last month v same month last year
 - Simple: compare actual consumption with budget
 - Simple: annualised trend of cost and consumption
- More complex
- Energy use per unit output
 - Cooling energy per cooling degree day
 - Specific energy consumption (SEC)
- Regression analysis
- Same methods apply to EnPIs and verification of savings

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What does this tell us?



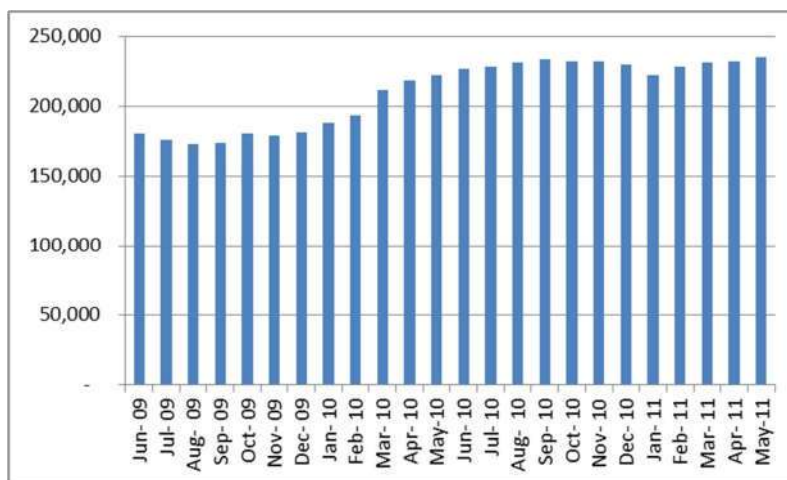
99

Annualised trend

- Moving total of previous 12 months (or 52 weeks, etc.)
- Removes seasonal effects
- Gives a real view of comparison v budget
- Effects of a change stay for next 12 periods
- Absolute numbers
 - No allowance for changing drivers or activity levels
- Very useful for forecasting, you can quickly judge what next 12 months use will be
 - You need to correct for known changes in output or other

100

Same gas data in annualised view



101

Beware of simple ratios

- Energy use per unit of output (Energy Intensity)
 - e.g. kWh/T of product
 - Useful in energy intensive industries for benchmarking internally and externally
 - Beware in others, especially in cases with large baseloads
 - Almost of no value in judging energy performance
 - Usually tracks output better than energy
- Energy Efficiency (energy in compared with energy out)
 - E.g. boiler efficiency is a useful indicator but beware:
 - Decreasing boiler load through pipe insulation, leak repair or demand management will almost always result in reduced boiler efficiency due to lower loads
 - Overall system efficiency will improve but not the boiler efficiency

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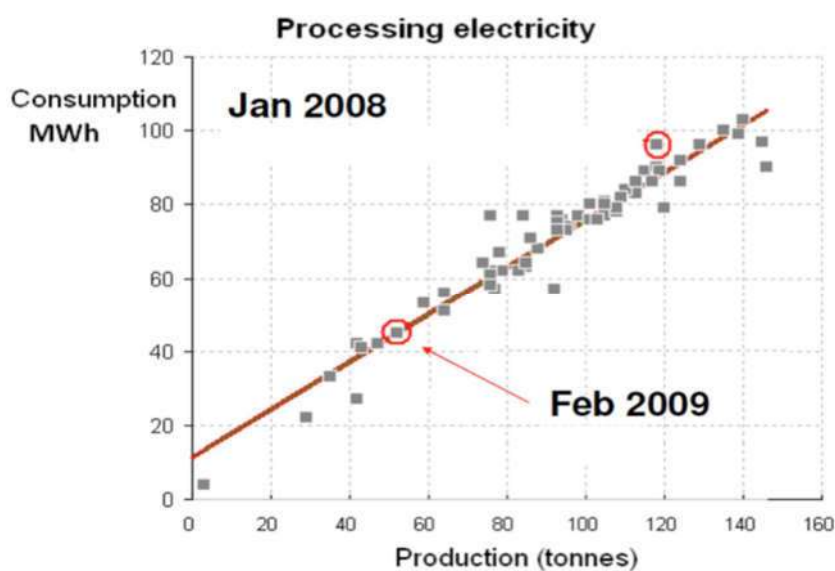
Other indicators to be careful of

- Specific Energy Consumption (SEC)
 - For example, air compressor SEC will usually increase if leaks are repaired, or demand reduced.
 - This does not mean you should not reduce demand
 - It means that care is needed in the use of this indicator
- Coefficient of Performance (COP)
 - Used as a measure of refrigeration plant performance
 - = cooling load (kW) / electrical power to compressor (kW)
 - COSP = cooling load (kW) / power to compressors plus auxiliaries loads such as fans and pumps
 - Often reduces as load reduces (centrifugal compressors can be an exception)

Month	consumed MWh	production tonne	MWh/tonne
January 2008	96	118	0.814
...
February 2009	45	52	0.865

What does this tell us about energy performance?

Do organisations really make decisions based on this?



105

Determining performance

- You cannot manage what you do not measure
- This is not the whole story
- It is not enough to know how much you used
- CRITICAL QUESTION: was it more than necessary?
- ISO 50001 requires the organisation to compare actual with expected energy use

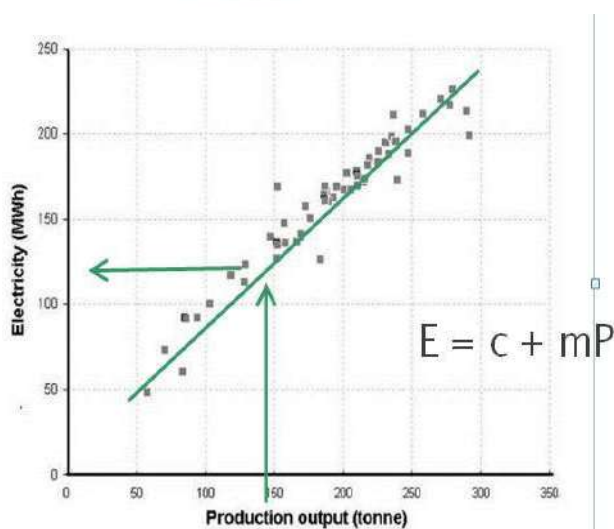
106

Problem: things make consumption vary

- Weather
 - Daylight availability
 - Production throughputs
 - Mileages
 - Occupancy
 - ...etc.
- *Terminology: drivers, independent variables, energy factors*
 - All mean the same, decide which you will use

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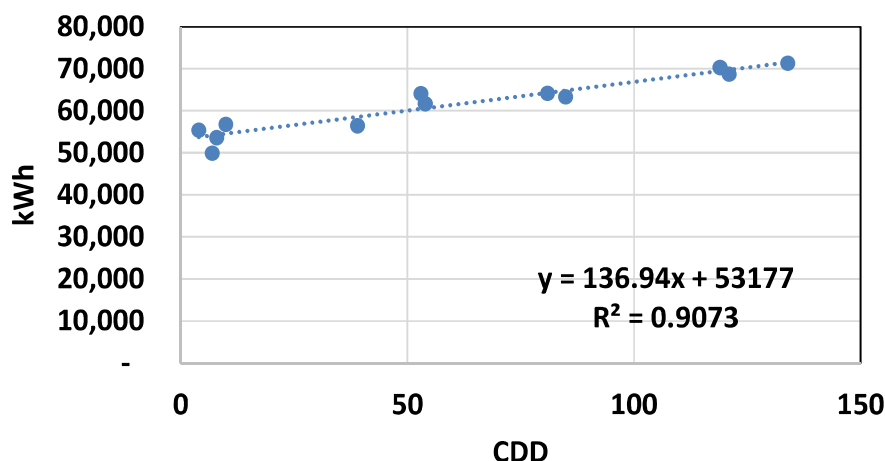
Simple process



Energy = constant + slope X Production

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2011 Chiller Electricity .v. CDD



109

Straight line formula

- $Y = mX + C$
- Energy (E) = Factor (F) * Driver (D) + Constant (c)
- $E = FD + c$
- In the previous case:
- $E/ec = 136.94 * CDD + 53,177$
- This formula can be used to predict expected consumption for any given driver
- We can compare predicted v actual usage to indicate performance

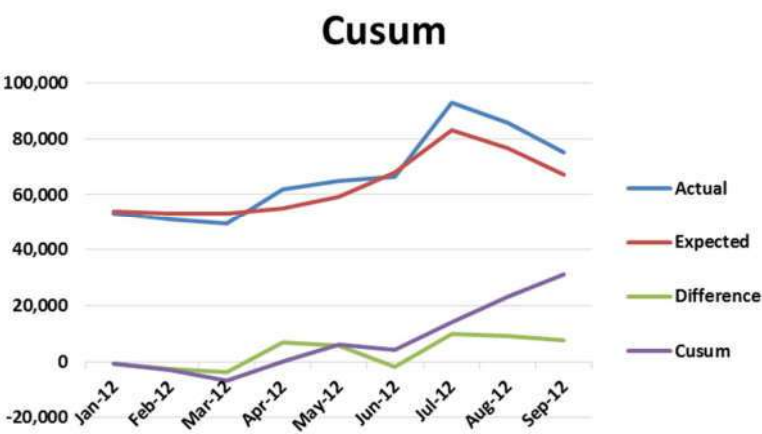
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Difference between expected and actual

	Actual	Expected	Difference	Cusum	Index	Excess Cost	Cum Excess
Jan-12	53,336	53,862	- 526	- 526	0.99	\$ -47	\$ -47
Feb-12	50,771	53,177	- 2,406	- 2,932	0.95	\$ -264	\$ -264
Mar-12	49,484	53,177	- 3,693	- 6,625	0.93	\$ -596	\$ -596
Apr-12	61,820	55,094	6,726	101	1.12	\$ 9	\$ 9
May-12	65,071	59,202	5,869	5,970	1.10	\$ 537	\$ 537
Jun-12	66,257	67,967	- 1,710	4,260	0.97	\$ 383	\$ 383
Jul-12	93,063	83,167	9,896	14,156	1.12	\$ 1,274	\$ 1,274
Aug-12	85,898	76,868	9,030	23,187	1.12	\$ 2,087	\$ 2,087
Sep-12	75,124	67,282	7,842	31,029	1.12	\$ 2,793	\$ 2,793

- Actual from bills
- Expected from regression formula
- Index = Actual/Expected
 - Highlighted cells are when index > 1

Difference between expected and actual



In general

- Expected energy consumption can be any function of relevant driving factors D
- $E = f(D1, D2, \dots, Dn)$
- Use the simplest effective model
- A straight-line relationship is often good enough

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The main message

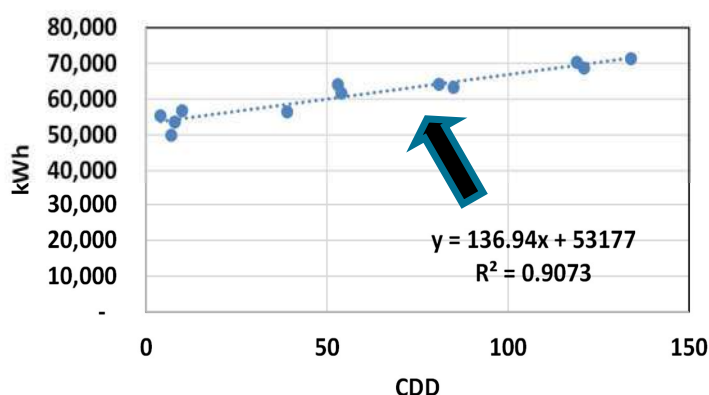
- Establish relationships between energy consumptions and appropriate energy variables
- Single or multivariate regression
- Use these to **calculate *expected consumption*** based on production activity, prevailing weather etc.
- Thereby detect unexplained deviations

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Baselines

- Baseline is initial model

2011 Chiller Electricity .v. CDD



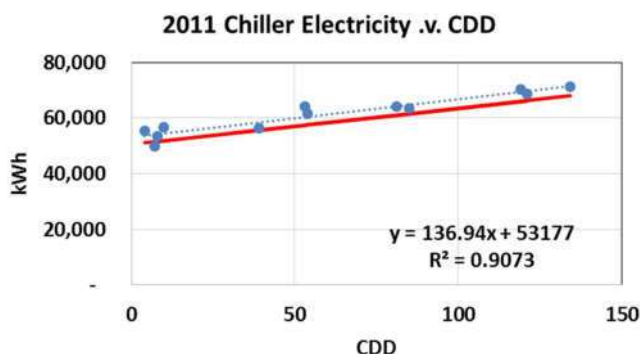
115

Baseline alternatives

- Baseline will be used for future comparison of improvements
- Ideally based on regression analysis as shown
- Can be absolute consumption, e.g. 1 GWh per annum
- SEC: kWh per unit of output
 - Not desirable or indicative of real improvement

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Baseline and Target Performance



- Alter the formula to reduce by targeted amount
- E.G. multiply coefficients by 0.95

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Historical baseline characteristic

- Answers the question *"how much would I have used in the absence of my energy-saving measures?"*
- Allows absolute kWh savings to be computed
 - Gives clean, objective view
 - Production, weather, etc. already accounted for

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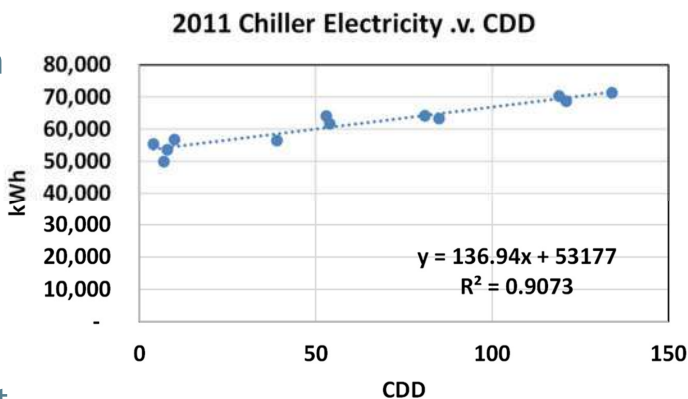
Cumulative savings can be tracked



119

Baseload

- The energy you use when there is no productive activity
- Very often a major opportunity for improvement
- Measure and analyse baseload if it is significant
- 53,177 kWh in this example



120

Energy Performance Indicators (EnPI)

- Budget v actual consumption
- Actual v expected or targeted consumption on a regular basis (e.g. daily, weekly or monthly)
- CUSUM of total energy and of each SEU

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Tomorrow's workshop

- Each group will need
 - ✓ One company to use as the organisation
 - ✓ Laptop with PowerPoint
 - ✓ Person to prepare slides
 - ✓ Bring Data from you own facility (energy and production)

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Day 1 End
Thank You

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EU – VIET NAM SUSTAINABLE ENERGY TRANSITION PROGRAMME (SETP)
Accelerating energy efficiency (EE) in larger industries through energy management systems,
system optimization and the promotion and adoption of EE in SMEs – (SEEP project)



Energy Management System (EnMS) Implementation Training

UNIDO International Energy Efficiency and EnMS Training

Day 2

Based on the contents of the UNIDO Practical Guide for
Implementing and Energy management System

Delivered by: Richard Morrison, Stefan Walta

1



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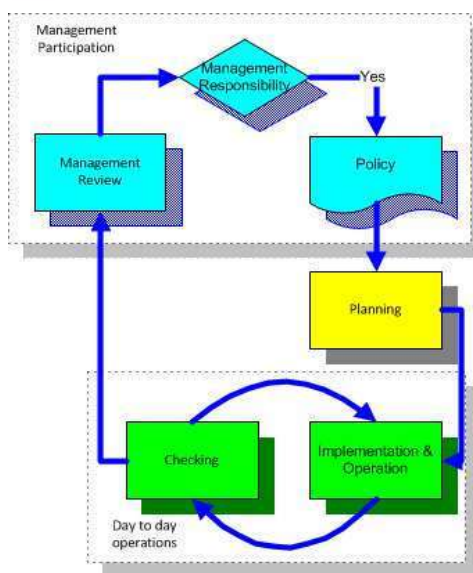
Day 2

Based on the contents of the UNIDO Practical Guide for
Implementing and Energy management System

2

Six Key Concepts

1. Commitment
 - Roles and Responsibilities
2. Significant Energy Users (SEUs)
3. Energy Performance Indicators (EnPIs)
4. Action Plan
5. Operational Control
6. Review



3

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Break		15	15:00	15:15
Business Case for Energy Management	75		15:15	16:30
Next Steps	30		16:30	17:00
Day 2 End			17:00	

4

What is this step

Doing - *Daily activities to improve energy performance*

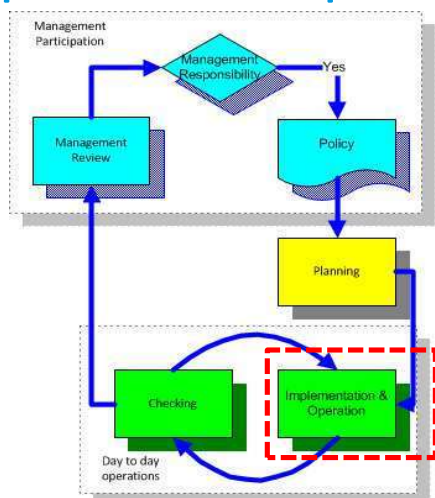
We have a policy with management support, resources, strategic direction and committed team members

We also have objectives, targets and action plans

Now, we must implement the action plans, day to day control and continuous improvement of our energy usage

5

Implementation & Operation



- Competence, training and awareness
- Documentation
- Operational control (**Key concept**)
 - Key Area
 - Operation and Maintenance
 - Service Contractors
 - Training
- Communication
- Design
 - Energy Efficient Design (EED)
- Purchasing energy, services, goods
- Action plans

6

Implementation & Operation

- This is a continuous daily process – not a project
- It needs to be part of day to day habits
- This is the part where energy savings and energy performance improvements are actually made
 - All other parts of the system support this
- This may be a major change for your organisation
- It may be a major change for you!!!
- Change is always difficult to manage
- Needs involvement, support and communication
- If you don' t change you can' t improve

If you want to make enemies, try to change something. ~Woodrow Wilson

7

Awareness

- All staff need to be aware of the EnMS
- All staff need to be aware of the energy policy
- All staff should be aware of the benefits to the organisation of improved energy performance
- It is usually desirable that all staff are aware of the issues surrounding energy efficiency
 - Climate change
 - Energy cost
 - Success stories
 - The organisations interest in these areas
 - Security of supply
- Feel good factor for employees

8

Training & Competence

- Staff with a significant impact on energy use need to be competent
 - Education
 - Training
 - Experience
 - Skills
- Training plans are to be implemented
- Potential consequences of departure from procedures
- Training records must be kept
- Include external service providers where relevant

9

Documentation

- Documentation requirements
 - Paper or electronic
 - Describe the core elements of the EnMS
 - Relevant records need to be available and controlled
- Control of documents
 - Approval prior to use
 - Periodic review and update
 - Revision control
 - Must be legible and identifiable
 - Readily located
 - Latest versions only in circulation
- Integrate into existing document control if available

10

Energy Manual

- This can be either hard copy or electronic
- You need direction to where all documents are located
- It is not necessary that all documents be included
 - Extra work in maintaining extra copies
 - Potential for error if duplicate copies in circulation
- Consider workflows rather than documented procedures
- Documents – expectations, who, what, etc.
- Records – demonstrate what has been done

11

Documents and Records list

Energy Management System Tools				
Documents				
ID	Description	Location	Revision	Revision Date
1	Energy Manual	Energy Manager Office	2	10/1/2010
2	Energy Bills	Finance Office	N.A.	N.A.
3	Boiler Operating Manual	Boiler control room	N.A.	4/23/2004
4	Planning Spreadsheet	S:/energy/records	N.A.	12/1/2010
5	Checking Spreadsheet	S:/energy/records	N.A.	N.A.
6	Energy Policy	S:/energy/documents	1	12/1/2010
7	Energy Audit reports - hard copies	Energy Manager Office	N.A.	N.A.
8	Energy Audit reports - electronic copies	S:/energy/reports	N.A.	N.A.
9	Training plans	Operating Spreadsheet	N.A.	N.A.
10	SEU Operator logs	relevant control room	N.A.	N.A.
11	Management review minutes	S:/energy/records	N.A.	N.A.

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Operational Control (Key Concept #5)

- This is a very critical part of the EnMS
 - Only a small part of ISO50001 and others
- Operation of SEUs
 - Operating parameters
 - Operating procedures
 - Logging (electronic and manual)
- Maintenance of SEUs
 - Maintenance procedures and schedules
 - Training of external contractors
- Monitoring of operations, records, action plan & EnPIs

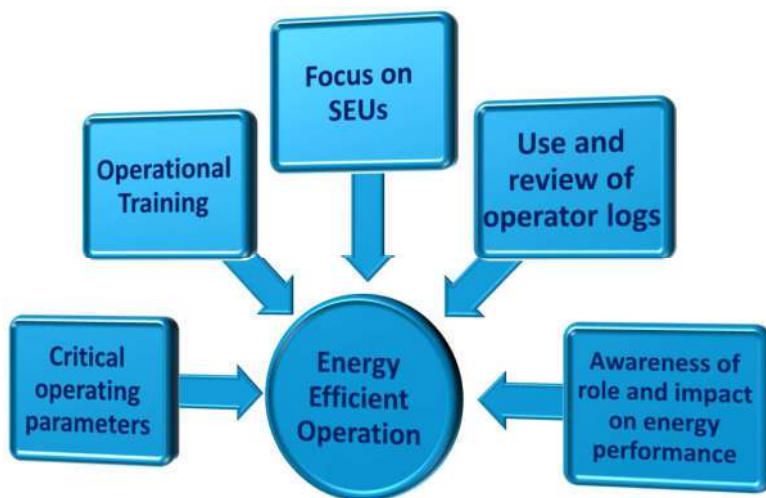
13

**It is critical that all significant energy users are operated
and maintained in the most energy efficient way feasible.**

This area is very commonly neglected

It is not difficult

14



15

Operator Logs

- Operator logs
 - Automated data collection – needs to be configured into report
 - Paper logs
 - Manual transfer of data into spread sheets - trending
- Critical operating parameters should be recorded regularly
- Other parameters that provide supporting information should also be logged
- Logs need to be reviewed routinely
 - Often they are only looked at when there is a breakdown
 - They can give early warning of problems if properly configured

16

Critical operating parameters

Energy Management System Tools										
Critical Operating Parameters										
SEU (inc use)	Parameter	Eng Units	Normal set point or value	Upper Limit	Lower Limit	Measuring Instrument Designation	Calibration Frequency	Who needs to be informed of these values?	Who needs to be informed of deviations?	Note
Steam system	Total Dissolved Solids	ppm	3500	3800	3400	TD5001	3 months	operators	supervisor	
Steam system	Boiler Pressure	bar	9.5	10	9	PT123	12 months	operators	supervisor	
Steam system	Exhaust Oxygen	% O ₂	3	3.5	2	Portable 123	6 months	operators	supervisor	
Steam system	Stack Temperature	DegC	N.A.	300	N.A.	TT124	12 months	operators	supervisor	Varies with firing rate
Pump 28	Differential pressure	bar	3	3.3	2.7	P28	24 months	Refrigeration	supervisor	
Refrigeration	Temperature Lift	DegC	25+/-10	35	15	T12 and T16	12 months	operators	supervisor	varies with the ambient wet bulb temperature
Refrigeration	Condenser approach temperature	DegC	5	6	N.A.	T12	12 months	operators	supervisor	

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18

Operation control - Maintenance

- The primary purpose of maintenance has traditionally been to maintain reliability and availability.
- If equipment is properly maintained it is more likely to be energy efficient also.
- Reactive maintenance will undoubtedly waste energy
- The cost of the energy will often be more than the cost of the maintenance (different budget!)
- All significant energy users need to be maintained correctly
- Applies equally to external service contracts as internal maintenance staff

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Simple Maintenance Tasks

4	Energy Management System Tools				
5					
6	Maintenance Criteria				
7					
9					
10	SEU (inc use)	Task	Frequency	Who needs to be informed?	Note
11	Steam system	Statutory inspection	12 monthly		
12	Steam system	Combustion testing	6 monthly		
13	Steam system	Chemical treatment testing	weekly		
14	Compressed air	filter replacement	6 monthly		
15					
16					
17					

20

Behaviour Change – operation control

- “We have always been operating (maintaining) things this way”
- “Why do we need to change?”
- “Production is critical – if we change something we may affect production”
- Change is uncomfortable
- It is difficult to sustain
- Communication is very important
- Discuss difficulties and solutions re: operation control

21

Discussion:

**Is it difficult to get an employee to change
temperature set points in the office of
your organisation?**

22

Implement the action plan

- Regularly check the action plan
- Are actions being completed on time?
- What are the barriers to completion?
- Are completed items meeting expectations?
- Are changes to the plan necessary?
- Look ahead for bottlenecks?
- Are there tasks that need a shutdown?
- Sort out any systemic barriers

23

Causes of failure to complete action items

- Ideas of Causes of failure?
- Lack of real commitment
 - Lack of focus, failure will not be poorly viewed
- Lack of technical ability
 - Need good ability to overcome other barriers
- “I’m too busy”
 - = lack of commitment
- Lack of finance
 - Should have been agreed at planning stage
- Lack of communication
 - Need to understand expectations
 - Need to understand roles

24

Communication

- On-going communication is required to embed the EnMS in your organisations culture
- You need to communicate with your staff:
 - Energy policy
 - Energy awareness
 - Progress on energy management
 - Success stories
- You need to give them an opportunity to contribute
 - Ideas and suggestions
- You need to decide if external communication is required
 - What, when, how and by whom

25

Design – Energy Efficient Design (EED)

Major opportunity to improve

Technical Changes

- Expansion, refurbishment, replacement
- Facilities, equipment, systems and processes

Energy Efficient Design

- Challenge user specification, use, distribution, generation

Consider the “Context of the Organisation” and any targets that the organisation has committed to such as “Net Zero” or energy performance improvement targets.

26

Energy Efficient Design (EED)

- Confirm **real** user requirements first
 - Pressure, temperature, flow, humidity, air changes, etc.
 - Integrate with other systems, e.g. use waste heat for space heating
 - Ensure lowest energy intensive service is used, e.g. hot water V Steam, Electric actuation V compressed air actuation etc.
- Design in user optimization features
 - Facilitate operational control in operation
- Design distribution system to minimise losses
- Design and size generation equipment **LAST**
 - It is often purchased first due to longer lead times
 - Include best available technology (BAT) and control
- EED will often reduce capital cost
- Allow for future expansion only if realistically expected
- Ensure energy metering is included in the project

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Energy Efficient Design

Challenge
energy
service

Ensure
operational
control is
facilitated

Design and
challenge
distribution
system

Design and
challenge
generation
system

Design and
challenge
controls

28

Pump System Example

Minimise user requirement
Shut bypasses
Determine actual flow and pressure requirement
Reselect motor and pump
Replace 150m³/h with 25m³/h
Save 75% or 176MWh p.a.



29

The importance of commissioning

- It is common to find well designed buildings and processes that are not energy efficient in operation
- The commissioning team need the following:
 - Understanding of the design intent of energy saving features
 - They need the expertise to be able to commission properly
 - They need the time to be able to do it properly (the lowest bidder may not have enough time)
 - The project schedule needs to allow enough time for correct commissioning
- The design intent and commissioning learnings need to be communicated to the operational team (training)

30

Procurement

- Can have a significant impact on your energy performance
- Inform all vendors that you have an EnMS that requires energy impact to be assessed as appropriate
- Ask vendors how they can help with your energy performance
- You need to be able to assess the energy performance and impact of items that you purchase
- Need to move towards Life Cycle Costing (LCC)

31

Purchasing energy

- Increasingly complex area with competition
- Need to know who are the potential suppliers
- Need to know your usage profile
- Need understanding of available tariffs
- Need understanding of specification of energy requirements
 - Voltage, maximum demand (kVA)
 - Viscosity and calorific value of fuels
- If significant energy savings are achieved through EE this may affect best tariff structure
- Need each supplier to quote for the same thing and same basis, need to be able to compare quotes

32

Purchasing goods

- Many items that we purchase have an impact on energy performance
 - Air compressors, motors, boilers, pumps, etc.
 - IT equipment, PCs, printers, photocopiers, etc.
 - Light bulbs
 - Maintenance materials, insulation, gaskets, bearings, lubricants, etc.
- We need to plan for this
- We need purchasing specifications for any of these items that we use

33

Purchasing services

- Any service provider who will affect your energy performance needs to be competent
- They include:
 - Maintenance service contractors for SEUs
 - Project engineers/managers
 - Architects
 - Energy consultants
- You need to be able to judge competence
 - Education
 - Experience of previous similar services
 - References
 - Curriculum vitae (CV) or resume

34

What about purchasing energy saving technologies?

- There are many vendors of energy saving technologies
- You need to be able to judge real saving potential from what the sales person says.
- Try a sample as a test
- How do you verify savings?
- Nobody admits to buying the wrong thing
- Some good technologies are only good in the right application, e.g. variable speed drives

35

Outputs from Implementation & Operation

- These are many and varied and thus this list is illustrative of what typically would be included
 - Training matrix, training records, CVs of contractors, etc
 - Documentation according to document management system
 - Operational records and logs
 - Maintenance records and service visit reports
 - Communication records
 - Project review methodology (EED)
 - Procurement procedures or processes

Energy savings and performance improvement

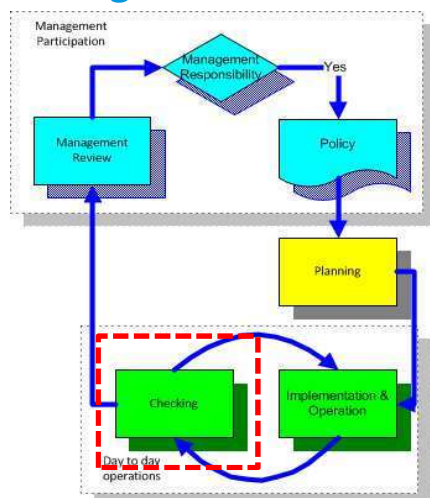
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Day 2 End			17:00	

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Checking



Check operations

- Check operation and maintenance records
- Check equipment

Check the system

- Is everyone doing what is required?

Check plans

- Is progress being made

Check performance

- Check EnPIs
- Check trends and costs

38

Checking

- In many ways this could be considered as part of implementation and operation
 - It is very much a parallel activity
- It is a day to day activity to ensure that equipment and systems are operating efficiently
- Give most attention to SEUs
- Someone should be completing operational checks on a regular (daily?) basis
- These form the basis of the operator logs referred to in operational control
- These logs need to be checked routinely and regularly
- Also check maintenance activities
- Importance of checking critical operating parameters

39

Checking Performance

- We have a baseline energy performance
- We have targets for performance improvement
- We need to know if we are meeting our performance improvement targets
- We have Energy Performance Indicators (EnPIs)
- This can be a complex topic depending on your industry and your energy drivers
- You need to regularly compare actual EnPIs with expected values
- Typically at least one EnPI per SEU

40

Significant Deviation

What is it?

- A major difference in the measurement of energy compared to expected energy.
- The equipment or process is not performing as expected based on the EnPI, Operational limits, etc.

What do I do?

- Investigate
- Take appropriate action
- Keep a record

41

Generating a non-conformity

- **Added Value** (continuous improvement)
- Beware of excess bureaucracy!
- On a day to day basis the requirements of the EnMS should be met
- If they are not then some form of correction is required
- Keep things in perspective
 - Do not issue a Non-conformity (NC) report if an action plan item is 1 day late
- Who should issue them?
- Who should action them?
- Who should review them?
- Who should receive reports?

42

Continuous Improvement Cycle

- Non-conformity
 - Not fulfilling a requirement
 - Beware of scope
 - Beware of excess deviation reports
- Correction
 - Action to rectify a problem, e.g. compressed air pressure drop
- Corrective action
 - Action including prevention of recurrence of a non-conformity
- Preventive action
 - Action to prevent a potential future non-conformity
- Internal Audit
 - Check that the system is being run in accordance with its requirements

43

Discussion

Are these worthy of a non conformance or a significant deviation or no action?

- An action plan item was completed one day late?
- An action plan item is late and it is significantly impacting performance?
- A critical operating parameter is consistently out of specification?
- The efficiency of a large boiler is 2% below optimum regularly?
- The lights in a big office are left on over a weekend?

44

Non-conformities

Energy Management System Tools								
Non-conformities								
ID	Description	Date Identified	Source	Corrective Action	Resp	Target Completion	Actual Completion	Potential consequences
NC1	Waste water treatment operators not trained in blower operation		Internal Audit	Complete training	JB	3/1/2011		Inefficient operations
NC2								
NC3								
NC4								
NC5								
NC6								
NC7								

45

What is an internal audit?

- Independent review of part or all of the EnMS
- The purpose is to determine if the following are meeting the EnMS requirements
 - Plans
 - Activities
 - Procedures and processes
- Is the EnMS effective in improving energy performance?
- Is the EnMS operating as intended?
- Is it achieving its objectives?
- Does the EnMS meet the requirements of a standard if certification is being sought, e.g. ISO50001
- It is an essential part of continuous improvement

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Who can carry out an internal audit?

- Must be competent
 - Reasonable knowledge of the process being examined
 - Know the EnMS
 - Familiarity with a standard (e.g. ISO50001) if appropriate
 - Is often an existing ISO14001 or ISO9001 auditor
- Must be independent
 - Shouldn't audit your own work
 - Or that of a direct report or your boss

47

What is reviewed

- Objectives, targets and action plans
- Legal and other requirements
- Policies, procedures, processes, records and operational controls including;
 - Energy review
 - Compliance with legal and other requirements
 - Awareness, training and competence
 - Communication
 - Document control
 - Record control
 - Non-conformances (deviation reports)
 - Internal audits (yes!)
 - EnPIs
 - Management reviews

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Internal audit plan

4	Energy Management System Tools								
5									
6	Internal Audits								
7									
	Instructions:								
8	Each audit will have a report and recommendations to improve the system.								
9									
10	Section	SEU	Jan	Feb	Mar	Apr	May	Jun	Jul
11	Record Keeping	Utilities	MM/JB						
12	EnPIs	Production unit 1		MM/JB					
13	EnPIs	Utilities			MM/JB				
14	Communications	Administration				MM/JB			
15	Objectives and Targets	Waste Water Treatment					MM/JB		
16	Operational Control 4.4.6	Production unit 2						MM/JB	
17	Planning	Refrigeration							
18	Non-conformances and corrective actions	HVAC							
19									

49

See you in 15 minutes!



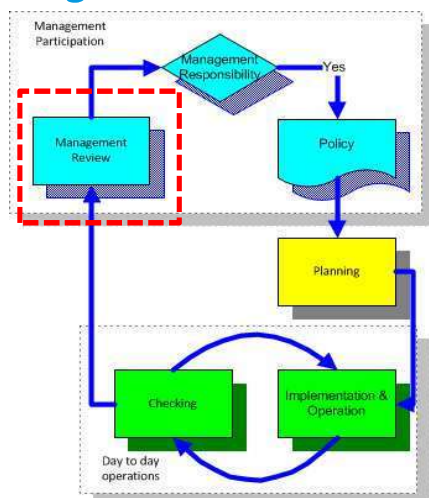
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Management Review



- Regular presentation
- How are we getting on?
 - Is performance improving as targeted?
 - Problems and barriers to overcome?
 - Achievements
- What is the plan for the next period?
 - What do we need to achieve this plan?

52

Purpose

"continue to build support for the system and its improvement"

- Demonstrate to the top management how well the system is performing
- Highlight problem areas where there may be barriers to improvement
- Continue to build support for the system
- Propose and agree plans for the coming period

53

When does it occur?

- There can be variation in the frequency of the review
 - Some organisations have it as a significant event and held possibly annually including all of the top management of the organisation
 - Others, especially if energy is a significant cost may hold it more frequently
- Hold one soon after the initial planning phase is completed
 - Get agreement on objectives and targets
 - Get approval for resources for the action plan
 - Build support for the programme

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Who should attend

- Relevant members of the senior management team
 - General Manager or Managing Director
 - Technical managers
 - Financial managers
 - Production managers
 - Engineering managers
 - Quality
 - Safety
- Presentation delivered by the energy manager
 - Or the senior management representative

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Management Review Agenda

Inputs to the management review shall include:

- a) the status of actions from previous management reviews;
- b) changes in external and internal issues and associated risks and opportunities that are relevant to the EnMS;
- c) information on the EnMS performance, including trends in:
 - 1) nonconformities and corrective actions;
 - 2) monitoring and measurement results;
 - 3) audit results;
 - 4) results of the evaluation of compliance with legal requirements and other requirements;
- d) opportunities for continual improvement, including those for competence;
- e) energy policy.

Inputs to the review also include:

- — the extent to which objectives and energy targets have been met;
- — energy performance and energy performance improvement based on monitoring and measurement results including the EnPI(s);
- — status of the action plans.

Source ISO 50001: 2018

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Outputs from the review

Outputs from the management review shall include any decisions or actions related to:

- a) opportunities to improve energy performance;
- b) the energy policy;
- c) the EnPI(s) or EnB(s);
- d) objectives, energy targets, action plans or other elements of the EnMS and actions to be taken if they are not achieved;
- e) opportunities to improve integration with business processes;
- f) the allocation of resources;
- g) the improvement of competence, awareness and communication.

Source ISO 50001: 2018

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DEMONSTRATE THE TOOLS IN EXCEL

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Today – Day 2

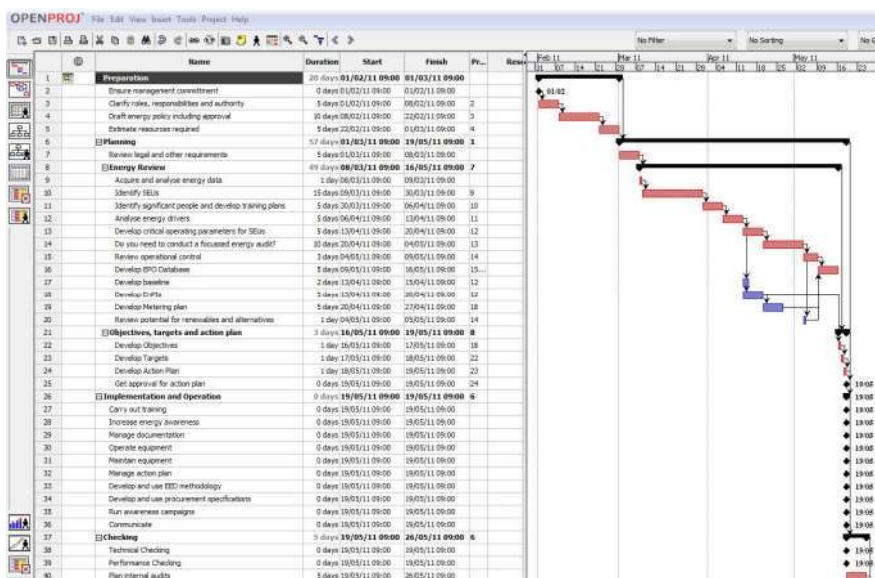
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Project Plan for implementation

- Useful for implementation of management system
- Sample of a project plan
 - Note: The implementation of an EnMS is a project
 - The use or operation of the EnMS is NOT a project
- Every organisation will be different
 - Different complexity and scale
 - Different approach to change management
 - Different cultures
 - Different speeds of action


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62 62

		Name	Duration	Start	Finish	Prede...
1		Preparation	20 days	01/02/11 09:00	01/03/11 09:00	
2		Ensure management commitment	0 days	01/02/11 09:00	01/02/11 09:00	
3		Draft energy policy including approval	10 days	01/02/11 09:00	15/02/11 09:00	2
4		Clarify roles, responsibilities and authority	5 days	15/02/11 09:00	22/02/11 09:00	3
5		Estimate resources required	5 days	22/02/11 09:00	01/03/11 09:00	4
6		Planning	54 days	01/03/11 09:00	16/05/11 09:00	1
23		Implementation and Operation	0 days	16/05/11 09:00	16/05/11 09:00	6
30		Checking	5 days	16/05/11 09:00	23/05/11 09:00	6
35		Management review	5.5 days	23/05/11 09:00	30/05/11 14:00	30






63 63

		Name	Duration	Start	Finish	Prede...
1		Preparation	20 days	01/02/11 09:00	01/03/11 09:00	
6		Planning	54 days	01/03/11 09:00	16/05/11 09:00	1
7		Review legal and other requirements	5 days	01/03/11 09:00	08/03/11 09:00	
8		Energy Review	46 days	08/03/11 09:00	11/05/11 09:00	7
9		Energy Consumption trends	1 day	08/03/11 09:00	09/03/11 09:00	
10		Identify SEUs	15 days	09/03/11 09:00	30/03/11 09:00	9
11		Identify significant people and develop training plans	5 days	30/03/11 09:00	06/04/11 09:00	10
12		Analyse energy drivers	5 days	06/04/11 09:00	13/04/11 09:00	11
13		Develop critical operating parameters for SEUs	5 days	13/04/11 09:00	20/04/11 09:00	12
14		Do you need to conduct a focussed energy audit?	10 days	20/04/11 09:00	04/05/11 09:00	13
15		Develop ECO Register	5 days	04/05/11 09:00	11/05/11 09:00	14
16		Develop baseline	2 days	13/04/11 09:00	15/04/11 09:00	12
17		Develop EnPIs	5 days	15/04/11 09:00	22/04/11 09:00	16
18		Objectives, targets and action plan	3 days	11/05/11 09:00	16/05/11 09:00	8
19		Develop Objectives	1 day	11/05/11 09:00	12/05/11 09:00	17
20		Develop Targets	1 day	12/05/11 09:00	13/05/11 09:00	19
21		Develop Action Plan	1 day	13/05/11 09:00	16/05/11 09:00	20
22		Get approval for action plan	0 days	16/05/11 09:00	16/05/11 09:00	21
23		Implementation and Operation	0 days	16/05/11 09:00	16/05/11 09:00	6
30		Checking	5 days	16/05/11 09:00	23/05/11 09:00	6
35		Management review	5.5 days	23/05/11 09:00	30/05/11 14:00	30

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		Name	Duration	Start	Finish	Prede...
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6		 Planning	54 days	01/03/11 09:00	16/05/11 09:00	1
23		 Implementation and Operation	0 days	16/05/11 09:00	16/05/11 09:00	6
24		Carry out training	0 days	16/05/11 09:00	16/05/11 09:00	
25		Manage documentation	0 days	16/05/11 09:00	16/05/11 09:00	
26		Manage action plan	0 days	16/05/11 09:00	16/05/11 09:00	
27		Develop EED methodology	0 days	16/05/11 09:00	16/05/11 09:00	
28		Develop procurements specifications	0 days	16/05/11 09:00	16/05/11 09:00	
29		Communicate	0 days	16/05/11 09:00	16/05/11 09:00	
30		 Checking	5 days	16/05/11 09:00	23/05/11 09:00	6
35		 Management review	5.5 days	23/05/11 09:00	30/05/11 14:00	30

65 65

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30		 Checking	5 days	16/05/11 09:00	23/05/11 09:00	6
31		Technical Checking	0 days	16/05/11 09:00	16/05/11 09:00	
32		Performance Checking	0 days	16/05/11 09:00	16/05/11 09:00	
33		Plan internal audits	5 days	16/05/11 09:00	23/05/11 09:00	
34		Carry out internal audits	0 days	23/05/11 09:00	23/05/11 09:00	33
35		 Management review	5.5 days	23/05/11 09:00	30/05/11 14:00	30
36		Plan management review	5 days	23/05/11 09:00	30/05/11 09:00	
37		Deliver reiew	0.5 days	30/05/11 09:00	30/05/11 14:00	36

66 66

What resources are required?

- Management Resources required
 - Consider the opportunity
 - Make the decision to go ahead
 - Review and approve the policy
 - Participate in the regular review meeting
 - Make on-going decisions as required
 - Offer encouragement and support
- Operational resources
- Implementation cost (for EnMS itself)
- Capital Investment

67

What resources are required?

- Management Resources required
- Operational resources
 - Completion of planning steps
 - Training is probably the largest
 - Support from other departments
 - Some time for energy manager to focus on EE
- Implementation cost (for EnMS itself)
- Capital investment

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What resources are required?

- Management Resources required
- Operational resources
- Implementation cost (for EnMS itself)
 - Consultancy support (if required)
 - Certification cost (if required)
- Capital investment

69

What resources are required?

- Management Resources required
- Operational resources
- Implementation cost (for EnMS itself)
- Capital investment is straightforward!
 - Either finance is justifiable and available or it isn't!
 - The focus of the EnMS is on low cost opportunities
 - Capital projects are also identified and justified

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What is financial appraisal?

- All organisations need to control spending
 - Current spending (expenses)
 - Capital spending (investment)
- Need to make choices of where to spend
 - Spend; Yes or No?
 - Choose between options for investment in savings project
 - Choose between options using life cycle cost (LCC)
- Need tools to help with these choices
- This is a basic introduction
- We will ignore the effects of taxes
- We will consider the effects of inflation and interest rates

72

Some financial choices

- Do you buy bread at \$1.20 or \$1?
- Two motors are the same
 - One costs \$300 and the other \$250
- Two motors are not the same
 - One costs \$300 and the other \$250
- I will give you \$1 now or \$2 in 12 months time?
- Two compressors:
 - One costs \$5,000 to buy and \$10,000 p.a. to operate
 - The other \$6,000 to buy and \$9,000 to operate
 - Which is best?

73

Simple payback (SPB)

- $SPB = \text{Cost in \$} / \text{Savings in \$ p.a.}$
- Usually organisations have a limit e.g. only opportunities with a payback of less than 3 years will be considered
- Advantages
 - Simple
 - Quick
 - Good rule of thumb
 - Useful as a quick estimate
 - Useful for low cost opportunities
- Disadvantages
 - Too simple
 - What is the effect of the life of the item?
 - Should not be used for major decisions, either high cost or organisationally critical

74

Simple payback (SPB) – Example 1

- Energy Savings that will be made = \$1000 p.a.
- Cost of modification = \$3000
- What is the payback?

75

Simple payback (SPB) – Example 2

- Energy Savings that will be made = \$1,000 p.a.
- Additional maintenance cost = \$500 p.a.
- Cost of modification = \$1,500
- What is the payback?

76

Time value of money

- Very important concept
- If I offer you the choice of \$5,000 now or \$800 p.a. for 10 years which would you choose?
 - You need to take into account the option of putting the \$5,000 in the bank and earning interest at say 10%
- Due to inflation money is worth less in the future than it is now
 - Assume 5% inflation
 - \$100 now is worth \$95 in one year
- We need to take this into account
 - Future savings are worth less than they are now
 - The reverse may be the case with savings if energy prices continue to rise

77

Net Present Value (NPV)

- Present Value (PV) or present worth (PW)
 - The value now of a future amount of money
- NPV is the value now of a future stream of cash flows
 - Can be incoming or outgoing and is typically a combination of both
 - Spreadsheets have an NPV function
 - Typically we spend money now to make a saving
 - Then we save money in the future on an ongoing basis
 - In energy terms we save energy each year
 - We may have extra maintenance costs (or less!)
 - We may have a salvage value at the end
- If $NPV > 0$ then it is a viable idea
 - If you have the money and it is the best NPV available

78

Life cycle cost (LCC)

- Life Cycle Cost can be used when considering the total cost of ownership of two alternatives
- For example you have two options
 - Option A: Buy a fixed speed pump for \$5,000 and annual running costs of \$7,000
 - Option B: Buy a variable speed pump for \$8,000 and annual running costs of \$3,000

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See you in 45 minutes!



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Structure of the workshop

- We will break into 4 groups
- This exercise is based on the operating plant that one of the group members works in
- The exercise should be carried out based on the needs and data of **that organisation**
- Each group will discuss the issues and prepare a 5 minute presentation
- The course leaders will move about to observe and answer any queries which will arise.
- The results will be presented in the next session.

82

The task.....

- Task 1
 - Persuade your management that EnMS implementation is beneficial for the organisation and address; developing an EnMS, main components, barriers to success, target areas for particular focus (May use Force Field Analysis)
- Task 2
 - Complete as much as possible of the planning stage of the EnMS. Where data is not available either make valid assumptions or describe exactly what data you need to fill in the gaps
- Task 3
 - Outline appropriate EnPIs for the organisation. Based on SEUs, and appropriate variables. Include measurement plans. Outline how this differs from current practices
- Task 4
 - Outline the steps that should be carried out in your organisation as part of implementation, operation and Checking and how that differs from current practices

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See you in 15 minutes!



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Energy Management

The Business Case

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Content/ Structure

- What is being proposed?
- The Current Situation
 - Energy consumption and costs
 - Energy cost trends
- What is Energy Management?
- What can be achieved?
- What could/can we achieve?
- How does it work?
- What do we do next?

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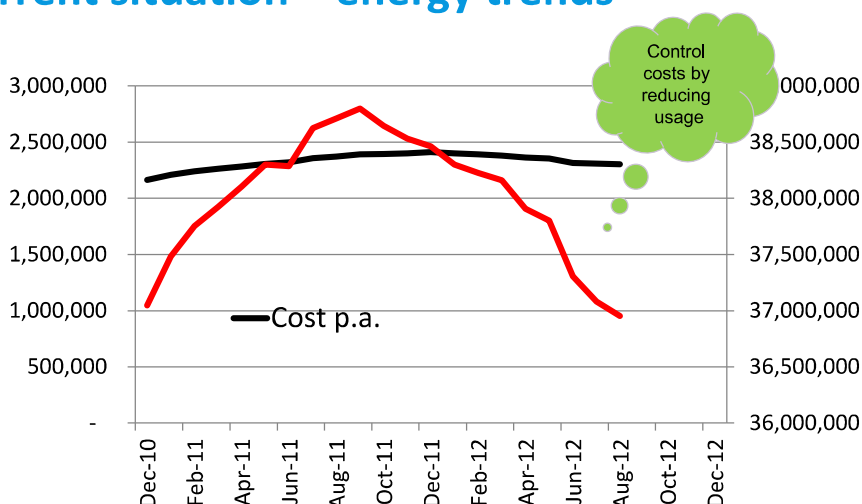
What is being proposed?

- ✓ Reduced operating costs
- ✓ Reduced exposure to rising energy costs
- ✓ Improved reliability and productivity
- ✓ Reduced environmental impact
- ✓ Improved corporate image
- ✓ Alignment with ISO 50001

Initially based on low cost improvements

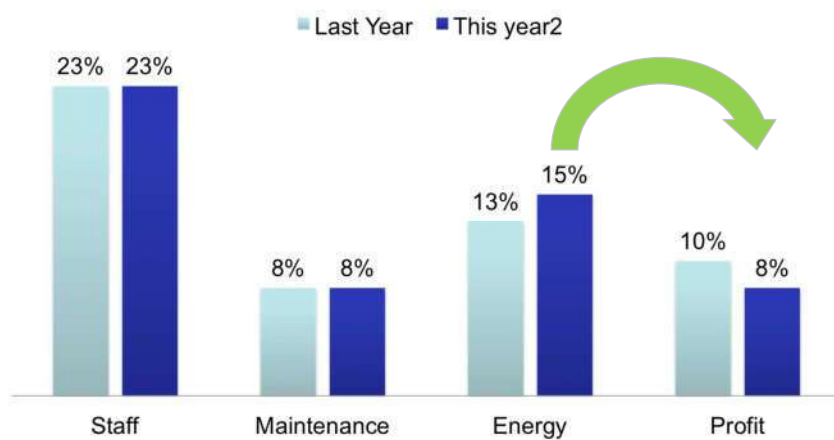
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The current situation – energy trends



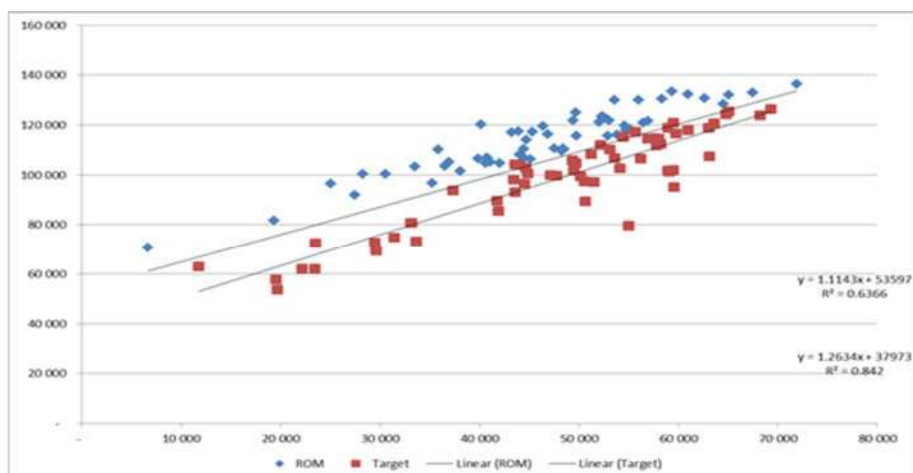
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Relative % of turnover



91

What can be achieved



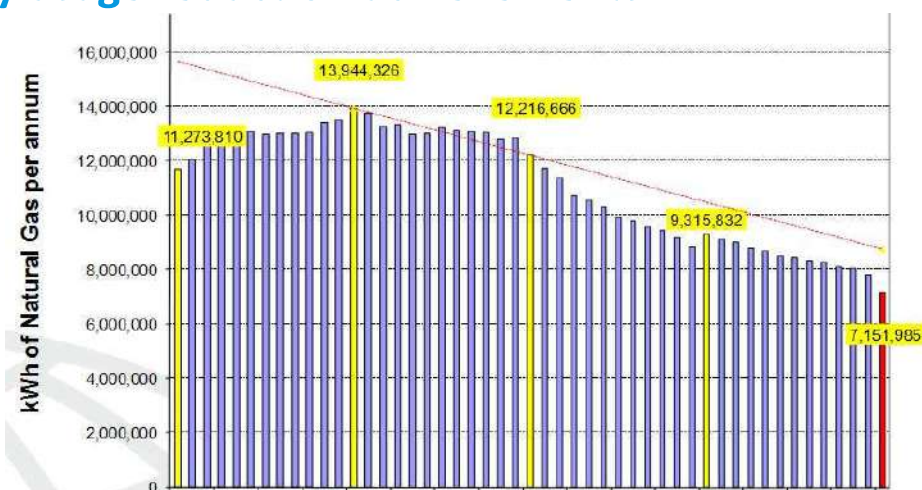
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What is energy management?

- It is how we propose to manage our use of energy!
- We want to be more systematic
- We will combine the following:
 - Behaviour change among all employees
 - Behaviour change among management
 - Objective use of data to show performance
 - Technical improvement
 - Low cost operation and maintenance of existing equipment

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Energy usage reduction achievements



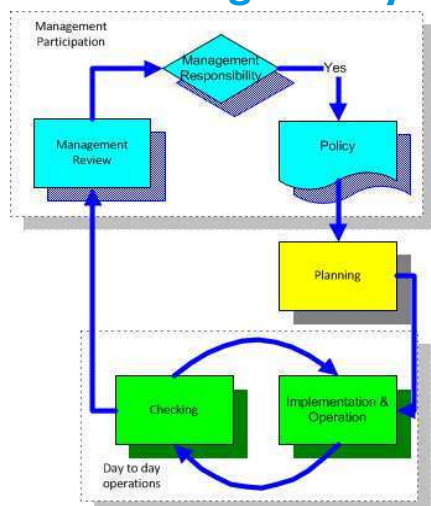
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Energy management assessment tool



95

It Works Using Six Key Concepts



1. Commitment
 - Roles and Responsibilities
2. Significant Energy Users (SEUs)
3. Energy Performance Indicators (EnPIs)
4. Opportunities List
5. Operational Control
6. Review

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What sort of actions will we take?

- Operation and maintenance initially
 - Fix leaks
 - Fix insulation
 - Switch off
 - Run optimum equipment
 - Optimum settings
 - Check controls
 - Training
 - Maintain improvements

97

What do we do next?

- Make a decision to go ahead
- We do not need financial investment until AFTER we start to show savings
- Viable investment projects may follow later
- We do need management commitment to improve
 - Some staff need to help
 - Some staff need to change behavior
 - Some staff need training

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Today – Day 2

Topic	Duration (hours)	Break duration	Start Time	End Time
DAY 2				
Implementation and Operation	45		08:30	09:15
Checking	45		09:15	10:00
Break		15	10:00	10:15
Management Review	15		10:15	10:30
Use of tools and online aids	40		10:30	11:10
Implementation Plan and Resources	20		11:10	11:30
Financial appraisal	30		11:30	12:00
Lunch		90	12:00	13:30
Workshop - planning, operating and checking	75		13:30	14:45
Delivery of Workshop Output	15		14:45	15:00
Break		15	15:00	15:15
Business Case for Energy Management	75		15:15	16:30
Next Steps	30		16:30	17:00
Day 2 End			17:00	

99

Next Steps for Enterprises - 1

Agree to go ahead and get commitment

- Management Commitment
- Consider certification
- Roles and Responsibilities
- Policy



Carry out the planning steps

- Collect data
- Use the spreadsheet tools
- Focus on SEUs
- Implement “no cost” items as soon as possible
- Develop training plans



Carry out the implementation and operation part

- Use the spreadsheet tools
- Start reviewing and updating O&M practices



Discuss the above vs your normal EM practice

100

Thank you

- It has been a pleasure working with you over these two days
 - We already knew it would be when we prepared the slides 😊
- On-going assistance is available according to contact details
- Remember: Keep it simple
- The best of luck with your future efforts to improve your energy performance or that of the organisations you are helping



Source: Microsoft

Energy Management System (EnMS) Expert Training

UNIDO International Energy Efficiency and EnMS Training

Module 1 Day 1

Delivered by: Richard Morrison, Stefan Walta

1

Welcome and Introductions

- Richard Morrison, Stefan Walta
- Name
- Organisation
- Energy Management Experience
- What do you expect to learn over this program?



2

Housekeeping

- Emergency Exits
- Toilets
- Mobile Phones
- Breaks
- Lunch
- Please restrict email to break times
- Interact and ask questions



Today

Start Time	End Time	TOPIC	DURATION (min)	EXERCISE (min)
08:00	08:30	Registration	30	
08:30	08:45	Welcome and Opening Remarks	15	
08:45	09:45	INTRODUCTIONS	30	
		* Exercise 01: Demonstrate File Share System		30
09:45	10:00	SETTING THE STAGE	15	
		* review UNIDO program objectives		
10:00	10:15	BREAK	15	
10:15	12:00	EXPERT TRAINING APPROACH	45	
		* Exercise 02: Team Building		60
12:00	13:30	LUNCH	45	
13:30	14:15	CONTEXT & MANAGEMENT COMMITMENT	20	
		* Exercise 03: Barriers & Countermeasures		25
14:15	15:00	ROLES, RESPONSIBILITIES & AUTHORITY	20	
		* Exercise 04: Responsibilities and Authority		25
15:00	15:15	BREAK	15	
15:15	15:45	SCOPE AND BOUNDARY	30	
		* HW: determine scope and boundary		
15:45	16:45	ENERGY POLICY	30	
		* Exercise 05: Develop Energy Policy		30
16:45	17:00	Daily Wrap-up	15	

Day 2

Start Time	End Time	TOPIC	DURATION (min)	EXERCISE (min)
08:30	08:45	ENERGY MANAGEMENT PLANNING PROCESS	15	
08:45	09:30	LEGAL AND OTHER REQUIREMENTS	25	
		* Exercise 06: Legal & Other		20
09:30	10:00	ENERGY REVIEW - Part 1	15	
		* Exercise 07A: Evaluate energy consumption		15
10:00	10:15	BREAK	15	
10:15	12:00	ENERGY REVIEW - Part 2	60	
		* Exercise 07B: Energy Balance & SEUs		45
12:00	13:30	LUNCH	90	
13:30	15:00	ENERGY REVIEW - Part 3	60	
		* Exercise 07C: Energy Opportunities		30
15:00	15:15	BREAK	15	
15:15	16:45	ENERGY PERFORMANCE & CALCULATING ENERGY SAVINGS	60	
		* Exercise 08: Calculate Energy Savings		30
16:45	17:00	Daily Wrap Up	15	

Day 3

Start Time	End Time	TOPIC	DURATION (min)	EXERCISE (min)
08:30	09:30	EnPIs AND BASELINE	60	
09:30	10:00	EnPI TOOL	15	
		* Illustrate EnPI Tool use with Data Set		15
10:00	10:15	BREAK	15	
10:15	11:30	* Exercise 09: Plant-wide EnPI Calculation		75
11:30	12:00	INTRODUCTION TO DOCUMENTS	30	
12:00	13:30	LUNCH	90	
13:30	15:00	OBJECTIVES, TARGETS & ACTION PLANS	60	
		* Exercise 10: Determining Objectives and Targets		30
15:00	15:15	BREAK	15	
15:15	15:30	MANAGEMENT REVIEW OF ENERGY PLANNING	15	
15:30	16:30	CHANGE MANAGEMENT	30	
		* Group Discussion: changing organizational culture		30
16:30	16:45	COMMUNICATIONS & NEXT STEPS	30	
16:45	17:00	Closing Remarks	15	

Today

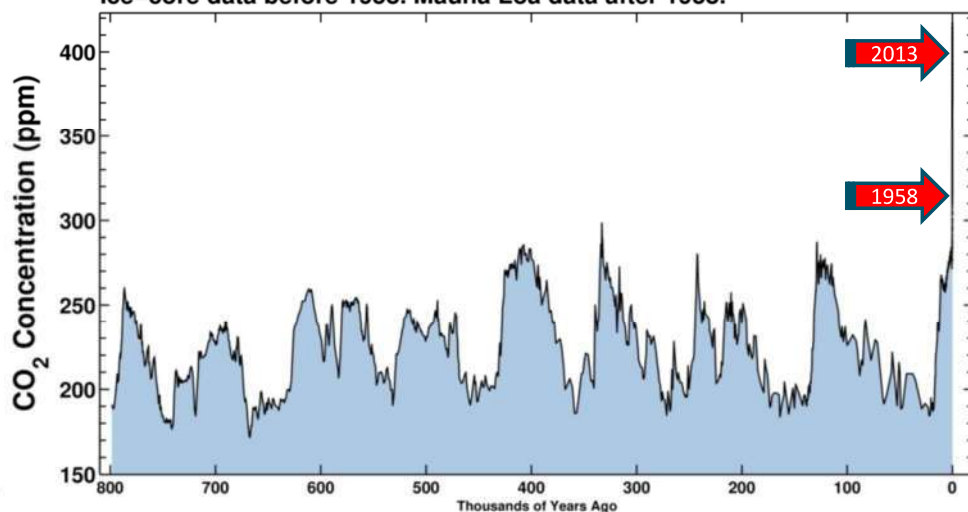
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10:15	12:00	EXPERT TRAINING APPROACH	45	
		* Exercise 02: Team Building		60
12:00	13:30	LUNCH	45	
13:30	14:15	CONTEXT & MANAGEMENT COMMITMENT	20	
		* Exercise 03: Barriers & Countermeasures		25
14:15	15:00	ROLES, RESPONSIBILITIES & AUTHORITY	20	
		* Exercise 04: Responsibilities and Authority		25
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15:15	15:45	SCOPE AND BOUNDARY	30	
		* HW: determine scope and boundary		
15:45	16:45	ENERGY POLICY	30	
		* Exercise 05: Develop Energy Policy		30
16:45	17:00	Daily Wrap-up	15	

Why do you need an energy management system (EnMS)?

Context: Energy costs, pollution, climate change
Better management practices

February 27, 2021

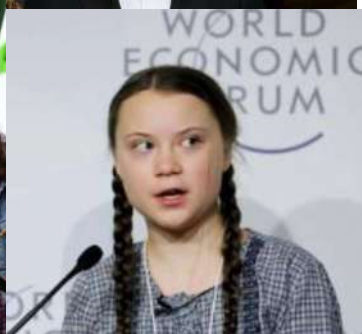
Ice-core data before 1958. Mauna Loa data after 1958.



9

Context: Climate change

Society is waking up!



10

Global environmental trends

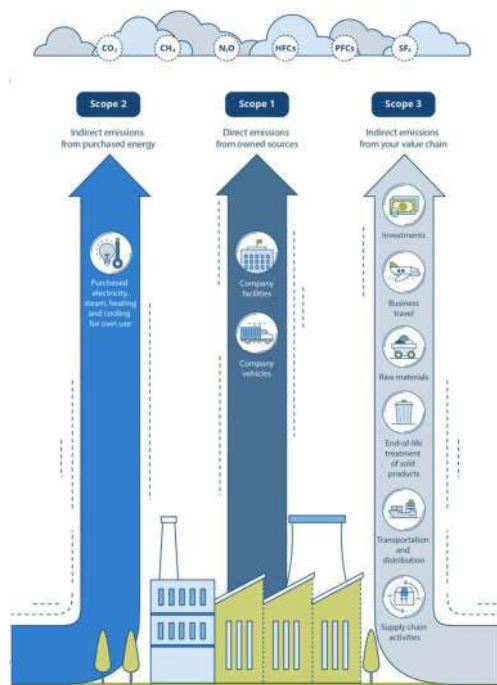


Source: Incite S.A.

11

Carbon footprint (GHGs)

- Scope 1 – Direct emissions
 - Boilers, combustion, vehicles, aircraft, ships, refrigerants
- Scope 2 – From imported energy
 - Electricity, district heating
- Scope 3 – Indirect – throughout the value chain
- Energy is 73% of total global Greenhouse Gas (GHG) emissions



SUSTAINABLE DEVELOPMENT GOALS



13

Overview of UNIDO and energy management program

14

Objectives of the UNIDO Global EnMS and ISO 50001 programme

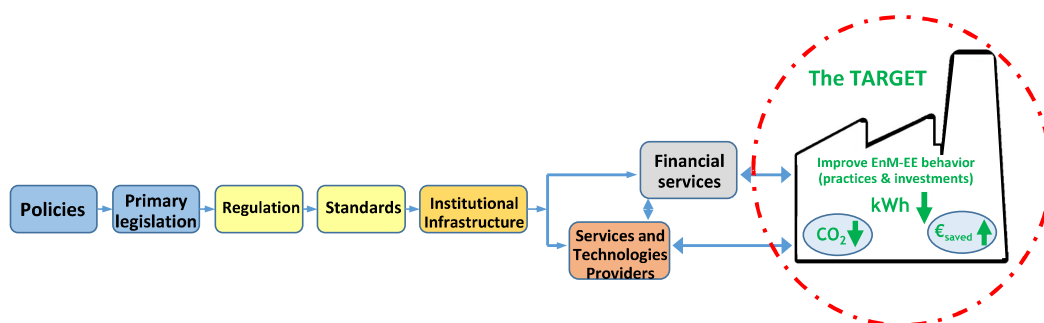
Work together with counterparts, enterprises and partners to:

- **Strengthen policy** and regulatory frameworks for better and sustainable energy performance in industry
- **Accelerate adoption** and wide dissemination of EE best-available practices and technologies
- **Save energy** and reduce GHG emission of the industrial sector
- **Integrate energy management and energy efficiency** in industry daily business practices for sustainable increased productivity and competitiveness



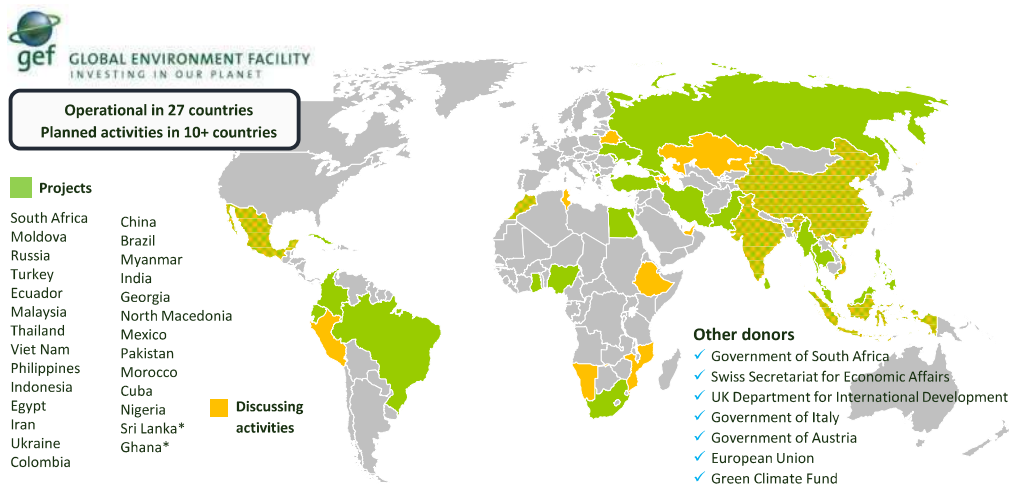
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To bear in mind



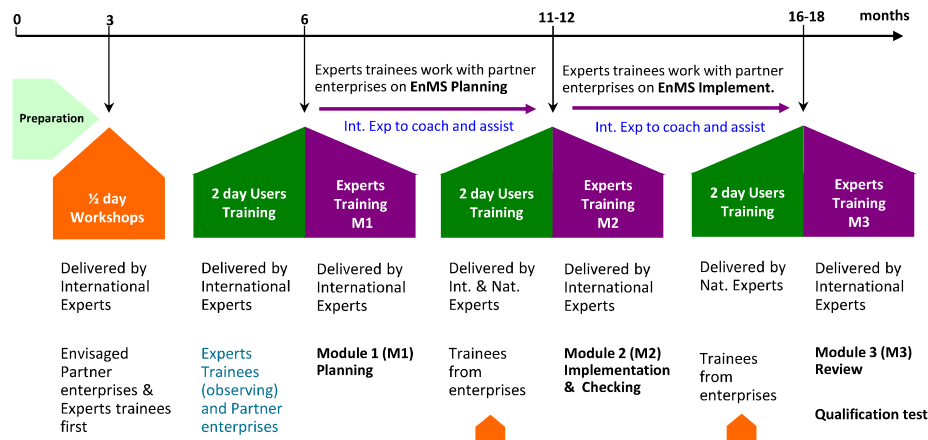
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UNIDO Global EnMS ISO 50001 Programme (2010-2021)

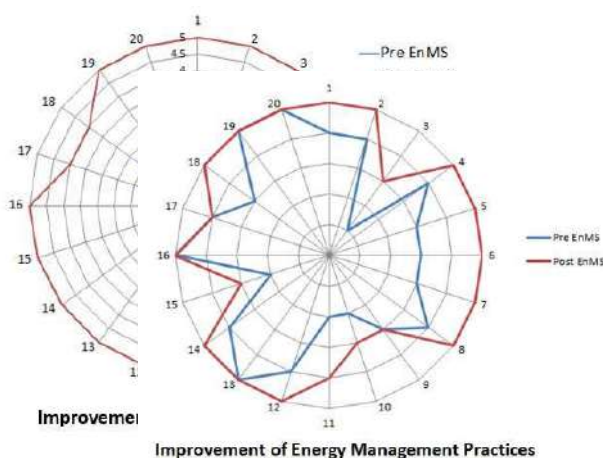
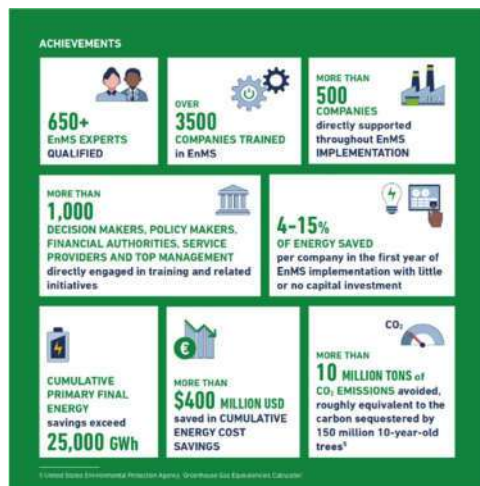


UNIDO EnMS Capacity Building programme

Envisaged scheduling



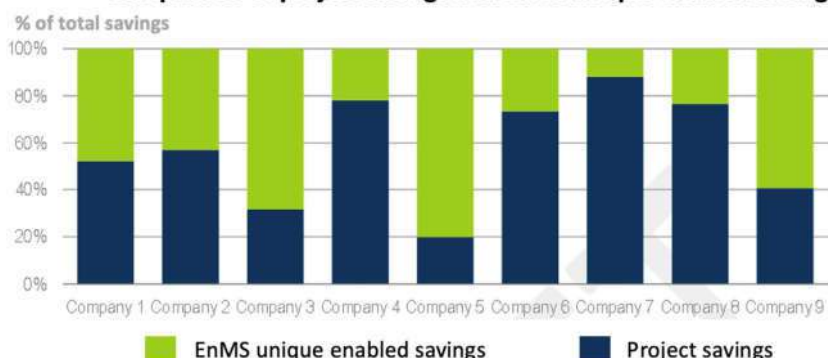
Impact of UNIDO EnMS-ISO 50001 Programme (2010-2020)



1.7

Separation of energy savings types

Comparison of project savings and EnMS unique enabled savings



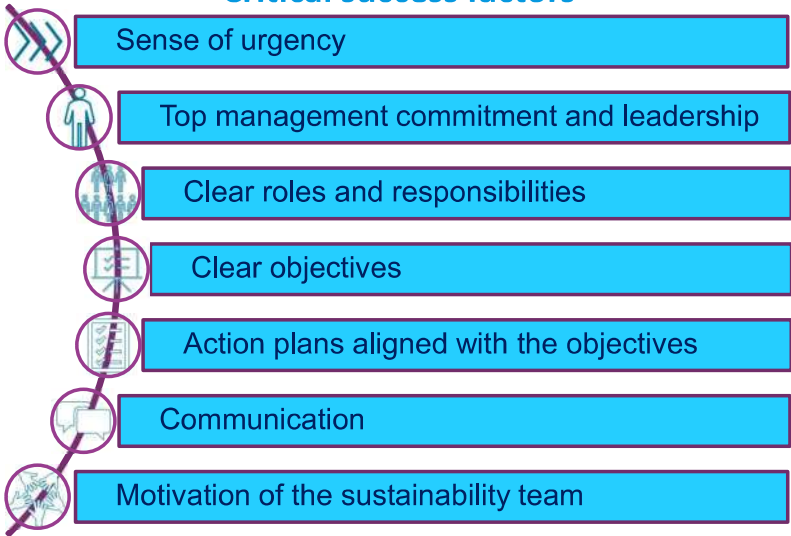
There is evidence that energy management systems unlock energy savings beyond those from technology replacement or process upgrades

Note: Companies 1-9 are medium-sized and large companies from metal processing, chemicals, automotive, construction material and power generation sectors in Egypt, North Macedonia, South Africa and Turkey

Comments from EnMS Early-Adopters

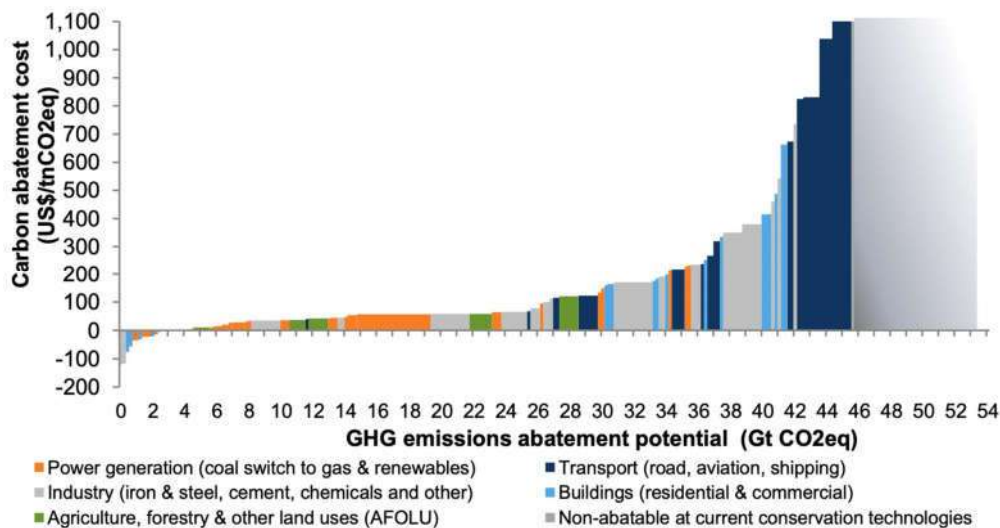
<p>Silakov Dmitry (chief energy Baltika SPB) «Main saving today coming from energy management with 0 cost» «Can not relax even for a moment , there must be permanent involvement of all staff»</p> <p>Evdokimov Alexander (chief energy Samara) «Grew up employee involvement because we have Roles and Reasonability matrix. Reporting become clearer and understandable.»</p> <p>Arcelor Mittal Saldana Works <i>“There must be a will to change ~ a “burning platform”. There must be a plan. There must be resources to implement the plan and The resources must be equipped with the requisite skills”</i></p> <p><i>“If you don’t care, the savings won’t happen – it’s all about attitude. Awareness and knowledge are key, and attitude is king.”</i> Superfilm (Packaging) Turkey</p>	<p>Zakharov Vladimir (chief energy Baltika Novosibirsk) «Before work with UNIDO we are already engaged in energy efficiency but don’t thought about the importance of consumers to a more detailed level»</p> <p><i>“Awareness and Knowledge are Key and Attitude is King. If you don’t know about potential savings opportunities you won’t look for them! If you don’t look for savings you won’t find them. If you don’t care – Savings won’t happen. It’s all about attitude!”</i></p> <p>Johnson Matthey <i>“ISO 50001 defines “WHAT” to do, UNIDO EnMS program defines “HOW” to do.”</i> Petkim (Petrochemicals) Turkey</p>
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Critical success factors



Critical success factors

- You need to be interested and willing to lead and drive this forward
- You need to win ongoing support from top management
- You need to learn how to improve energy performance through:
 - People
 - Technology
 - Information
- You need to learn how to measure energy performance



Source: Goldman Sachs ,Carbonimics

UNIDO Industrial Energy Efficiency Programme

Taking a Comprehensive Approach

Objectives: To reduce GHG emissions & enhance competitiveness of industry through improved energy efficiency and the transformation of the market for industrial energy efficiency products and services

Project components

1. Policy and institutional support
2. Capacity building (EE service providers, vendors and enterprises)
3. EE projects development and implementation
4. Development of/ support to IEE investment supporting schemes (in partnership with financing institutions)

UNIDO Industrial Energy Efficiency Programme

Example of country project

Project objective	To reduce GHG emissions and enhance competitiveness of industry through improved energy efficiency and the transformation of the market for industrial energy efficiency products and services
Project components:	
Policy and institutional support	Development and establishment of: <ul style="list-style-type: none"> ✓ National Energy Management Standard compatible with ISO 50001 ✓ National IEE Monitoring, Verification and Benchmarking Programs ✓ IEE Best-Practice Information, Dissemination and Recognition Programs ✓ Incentives for IEE and other
Capacity-building	<ul style="list-style-type: none"> ✓ Energy Management Systems (EnMS) Expert Training ✓ System Optimization (SO) Expert Training (steam, pumps, compressed air, ..) ✓ Development and provision of tools to assist industry in developing and implementing EnMS and system optimization projects ✓ Training of industry energy managers and engineers
Pilot IEE projects	<ul style="list-style-type: none"> ✓ Implementation of pilot EnMS and SO projects in selected enterprises
Financing for IEE	<ul style="list-style-type: none"> ✓ Development of IEE investment supporting schemes in partnership with international as well as national financing institutions

Factors for successful EE capacity building

- Skills for system optimization and energy management can be transferred through concentrated training programs
- Cultural context is important
- Provides opportunities for hands-on experience and learning-by-doing
- Ensure technical support for an adequate period of time
- Provide tools to support implementation and platforms for sharing experiences
- **Management support and engagement is essential** for successful capacity building and sustainable EE projects implementation
- Large energy savings can be identified and achieved

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UNIDO EnMS Capacity Building programme

Elements, target groups and objectives



Target group:
Top management

Objective:
To buy in EnMS and SO and the project



Target group:
Management repr., energy managers and other personnel of enterprises/ org.

Objective:
Enable to develop and implement EnMS



Target group:
EE consultants, ESCOs, ISO 14001 experts and others

Objective:
Enable to provide EnMS dev. & impl. TA and training

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UNIDO EnMS Capacity Building programme

½ day EnMS Awareness Workshop

½ day Awareness
Workshop

Target group: Enterprises’ top management

Objective: To get enterprises buying into EnMS (& SO) and decide to send staff to project trainings

2 day Users
Training

Modality: ½ day, business language, networking

Outputs: Top management understands

- ✓ Economic and strategic benefits of EnMS and relevant resources requirements
- ✓ Technical assistance made available by UNIDO-EBRD projects and relevant “partnership requirements”



Enterprises’ staff is sent to 2 day Users training

UNIDO EnMS Capacity Building programme

2 day EnMS Users Training

½ day Awareness
Workshop

Target group: Management representative, energy managers and other enterprises personnel

Objective: Enable enterprises to implement EnMS

2 day Users
Training

Modality: Preparation, class-room, workshop

Outputs: Enterprises’ staff

- ✓ Understands all elements of EnMS in line with ISO 50001 and the use of tools provided to support implementation
- ✓ Is able to put together a high-level project management plan (time, resources, costs, etc) to implement an EnMS
- ✓ Is able to report back on the EnMS and its benefits to top management

Experts
Training

UNIDO EnMS Capacity Building programme

2 day EnMS Users Training – cont.



- Requirements for enterprises attending:**
- ✓ Select/appoint right staff to attend the training
 - ✓ Allocate staff time for preparation to the training (i.e. collection of basic info for self-assessment)
 - ✓ Allocate staff time for attending the training (i.e. collection of basic info for self-assessment)
 - ✓ Provide feedback on EnMS implementation progress, if applicable

UNIDO EnMS Capacity Building programme

EnMS Experts training



- Target group:** National EE consultants, ESCOs, ISO 14001 experts and others
- Objective:** Enable to provide EnMS technical assistance (dev. & impl.) and training enterprises
- Modality:** Class-room, learning-by-doing, pairing with selected enterprises (**partner enterprises**)

UNIDO EnMS Capacity Building programme

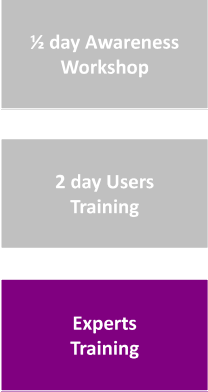
EnMS Experts training



- Structure:**
- Module 1: Planning**
 Trainees apply skills and work with partner enterprises under the remote supervision and coaching of international experts
- Module 2: Implementation and Operation**
 Trainees apply skills and work with partner enterprises under the remote supervision and coaching of international experts
- Module 3: Checking and Management Review and Qualification test**

UNIDO EnMS Capacity Building programme

EnMS Experts training



- Outputs:**
- ✓ Trained experts are able to work with enterprises to establish and implement effective EnMS, in conformance with ISO 50001
 - ✓ Trained experts are able to deliver the 1/2 day Awareness workshop and present technical and financial assistance available
 - ✓ Trained experts are able to deliver the 2-day Users training to enterprises’ energy managers/personnel
 - ✓ Partners enterprises implement EnMS in line with ISO 50001 and improve their energy performance (i.e. save energy and costs)

UNIDO EnMS Capacity Building programme

EnMS Experts training – cont.2



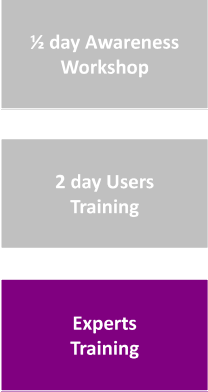
Requirements for trainees :

- ✓ To make a commitment to attend the full Expert training program. Estimated time requirements per trainee
 - 7-8 days for class-room training
 - 10-15 days to work with one partner enterprise in establishing and implementing an EnMS

Qualified trained EnMS experts will be recruited by the UNIDO project to deliver ½ day Awareness workshops and 2 day Users trainings

UNIDO EnMS Capacity Building programme

EnMS Experts training – cont.2



Requirements for Partner enterprises:

- ✓ To send their energy management representative (other staff optional) to the 2 day Users training
- ✓ To allocate staff time (management representative and other personnel) for
 - collecting energy information and data
 - working with national and international experts to establish and implement an energy management system
- ✓ To make a commitment to implement EE measures that meet agreed financial and economic criteria
- ✓ To report to the UNIDO project on activities performed and energy performance improvements (without disclosing confidential information)

Expert Training Approach

- PPT 02
- Expert Training – Phase 1
- Date
- Location

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What Will We Be Doing?

- Building national capacity
- Developing national experts who can assist industry to implement an Energy Management System (EnMS)
- Learning through training and practical application of an EnMS

Experts
Training

Target group:

EE consultants,
ESCOs, ISO 14001
experts and others

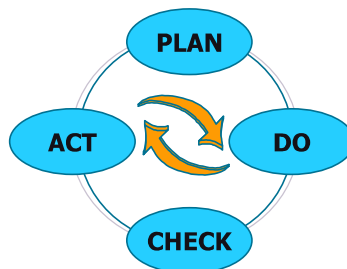
Objective:

Enable to provide
EnMS dev. & impl. TA
and training

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Phased Approach

- Three phases
 - Phase I: Plan
 - Phase II: Do
 - Phase III: Check & Act
- Workshops to kick-off each phase
- Training, coaching and deliverables are phase-driven



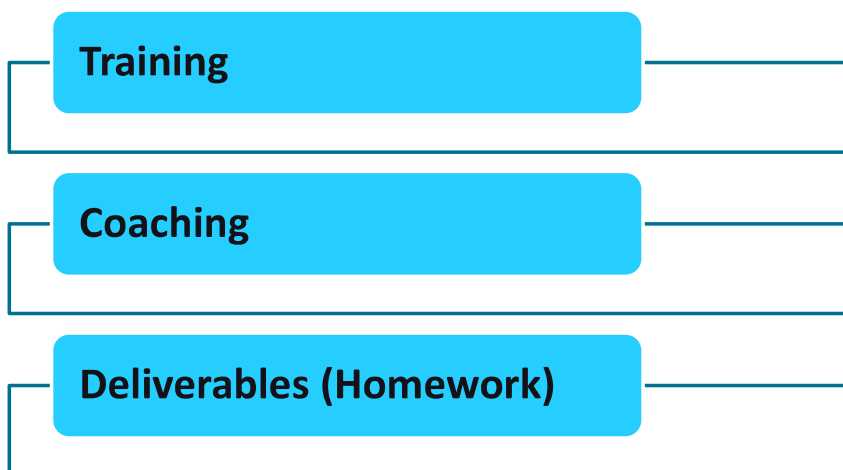
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Phased Approach

- Implementing a Plan-Do-Check-Act (PDCA) process
 - **Plan:** establish the data, goals and processes necessary to deliver results
 - **Do:** implement the processes
 - **Check:** monitor and measure energy performance and the processes against the policy, goals, targets, legal and other requirements, and report results
 - **Act:** take actions to continually improve energy performance and the energy management system

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Key Components



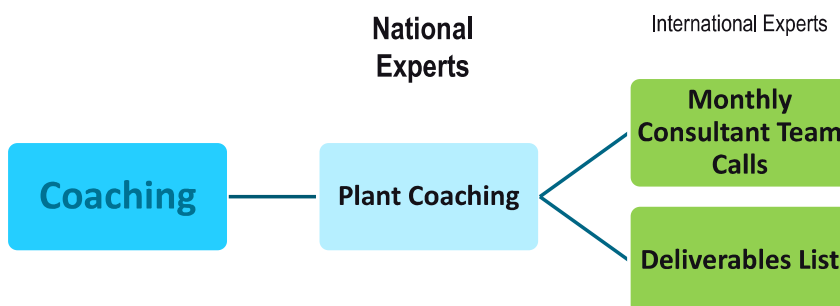
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Resources & Responsibilities



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Resources & Responsibilities



43

Resources & Responsibilities



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Calendar

List of Events

- **Workshops** (National Experts, International Experts)
- **Webinars** (National Experts, International Experts)
- **Deliverables Submission** (Demonstration plant, National Experts)

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Presentation Outline

- a) Understanding an EnMS
 - Considerations
 - Making connections
 - Value to the organization
- b) Expert role
 - Implementation guidance
 - Best practices
- c) Typical barriers
- d) Exercises
 - Tools
- e) Deliverables
 - Actions, documents & records

Expert training will have some repetition from 2-day end-user training but will be more focused on exercises.

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Tools - Examples

- Team Contact List
- Monthly Consultant Call Schedule
- Energy policy worksheet
- Energy Review Worksheet
- EnPI Tool
- Opportunity prioritization checklist
- Objectives & targets worksheet



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Multiple Consultant Model

- Several national experts teaming with demonstration plant to implement EnMS
- Conflicting messages and styles can delay implementation
- Teams will match consultants and companies
- Consequences of not working together:
 - Not included in national training program
 - Will not be certified as trainers or service providers

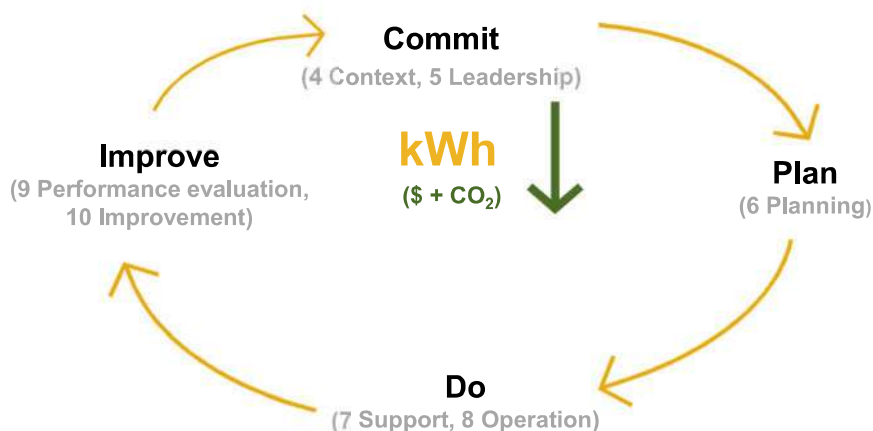
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Remote Coaching

- Coaching of National Experts by International Experts
- Coaching demonstration companies by national experts
- Regular meetings:
 - Monthly webinars for national experts by international experts
 - Bi-monthly meetings for demonstration plants and national experts
- Website for posting deliverables and sharing documents

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EnMS Cycle



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Structure of ISO 50001:2018

1	Scope	1	8	Operation	14
2	Normative references	1	8.1	Operational planning and control	14
3	Terms and definitions	1	8.2	Design	15
3.1	Terms related to organization	1	8.3	Procurement	15
3.2	Terms related to management system	2	9	Performance evaluation	15
3.3	Terms related to requirement	3	9.1	Monitoring, measurement, analysis and evaluation of energy performance and the	15
3.4	Terms related to performance	4	9.1.1	General	15
3.5	Terms related to energy	6	9.1.2	Evaluation of compliance with legal requirements and other requirements	16
4	Context of the organization	7	9.2	Internal audit	16
4.1	Understanding the organization and its context	7	9.3	Management review	17
4.2	Understanding the needs and expectations of interested parties	7	10	Improvement	18
4.3	Determining the scope of the energy management system	8	10.1	Nonconformity and corrective action	18
4.4	Energy management system	8	10.2	Continual improvement	18
5	Leadership	8	Annex A	(informative) Guidance for use	19
5.1	Leadership and commitment	8			
5.2	Energy policy	9			
5.3	Organization roles, responsibilities and authorities	9			
6	Planning	10			
6.1	Actions to address risks and opportunities	10			
6.2	Objectives, energy targets and planning to achieve them	10			
6.3	Energy review	11			
6.4	Energy performance indicators	11			
6.5	Energy baseline	12			
6.6	Planning for collection of energy data	12			
7	Support	12			
7.1	Resources	12			
7.2	Competence	13			
7.3	Awareness	13			
7.4	Communication	13			
7.5	Documented information	13			
7.5.1	General	13			
7.5.2	Creating and updating	14			
7.5.3	Control of documented information	14			

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See you in 15 minutes!



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Exercise 02: Team Building

Leadership Compass



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Exercise Format

- Step 1: Determine your work approach
- Step 2: Define your direction
- Step 3: Plan a vacation
- Step 4: Characterize work style



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Step 1: Work Approach

1. Review the 4 approaches to work – North, South, East and West.
2. Determine which work style best describes you.
3. Join your small group at the flip chart labeled with your compass direction.

Having difficulty? Ask yourself:

- What seems most comfortable?
- What is your tendency when under pressure?
- What is your first inclination when you get a new project?



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North: The “Get It Done” person



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North: The “Get It Done” person

Approach to work

- Assertive, Active, Decisive
- Likes to be in control and determine the course of events
- Quick to act, expresses urgency for others to act quickly also
- Enjoys challenging people and situations
- Thinks in terms of the “bottom line”
- Likes a quick pace and the fast track
- Courageous, Ambitious, and Confident
- Perseveres – Not stopped by “No”
- Goal-centered, ambitious
- Hardworking leader who is comfortable being in front
- Value Words – “Do it now!” “I will do it.”

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South: The Nurturer



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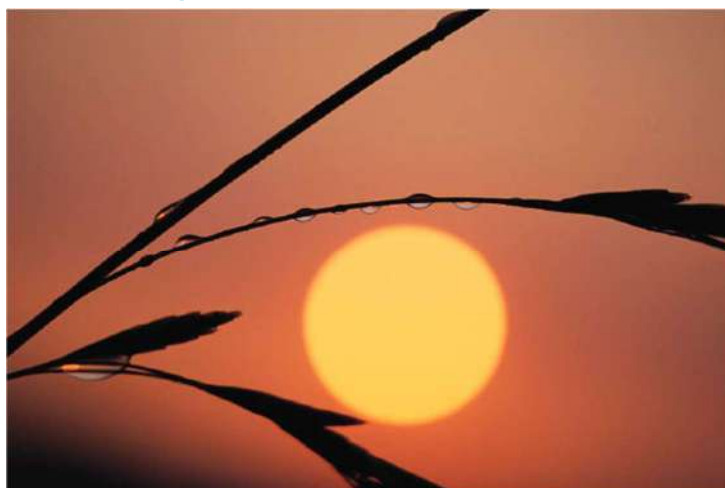
South: The Nurturer

Approach to work

- Friendly, likeable team player
- Allows others to feel important
- Supportive, nurturing and caring towards colleagues
- Willing to trust others' statements at face value
- Peace-loving, sympathetic, and helpful
- Feelings-based, trusts own emotions and intuition as truth
- Able to focus on the present moment
- Process-centered
- Generous, non-competitive and likes to build on the ideas of others
- Value Words: "Right" and "Fair"

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East: The Visionary



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East: The Visionary

Approach to work

- Innovative, Creative and sees the big picture
- Very idea oriented, focuses on future thought
- Risk-taker, adventurous, spontaneous
- Has insight into mission and purpose
- Looks for overarching themes and ideas
- Appreciates a lot of information
- Strong spiritual awareness, free spirited, unconventional
- Likes to experiment and explore
- Value words: "Option" "Possibility"

61

West: The Analyst



62

West: The Analyst

Approach to work

- Seen as practical, dependable, and thorough
- Provide planning and resources to others
- Moves carefully, deliberately, and follows procedures and guidelines
- Use data to make logical and analytical decisions
- Weighs all sides of an issue, balanced
- Introspective, self-analytical, focused, reserved
- Careful, thoroughly examines people's needs in situations
- Works well with existing resources – gets the most out of what has been done in the past
- Skilled at finding the fatal flaw in an idea or a project
- Value Words: "Objective," "Organized"

63

Step 2: Define your Direction

On the flip chart:

1. List what is really great about being your "direction" .
2. List what is really hard about being your "direction" .

You have 10 minutes!

64

Step 3: Vacation Planning

1. Each group will plan a vacation. Describe the vacation including what, where, how and why.

You have 15 minutes!

2. Assign a spokesperson.
3. Each group has **3 minutes** to describe their vacation.



65

Step 4: Work Style

1. Brainstorm the best ways to work with your “direction” .
Choose the top 3 ways to work with your “direction” .

You have 5 minutes!

2. Assign a new spokesperson.
3. Each group has **2 minutes** to describe the top 3 ways to work with your “direction”



66

See you in 45 min 😊



67

Context

External and internal context

68

The importance of your context

The energy context of your organisation is going to be a big driver for success

Use it to create a sense of urgency

Use it to motivate top management

Communicate it to relevant people

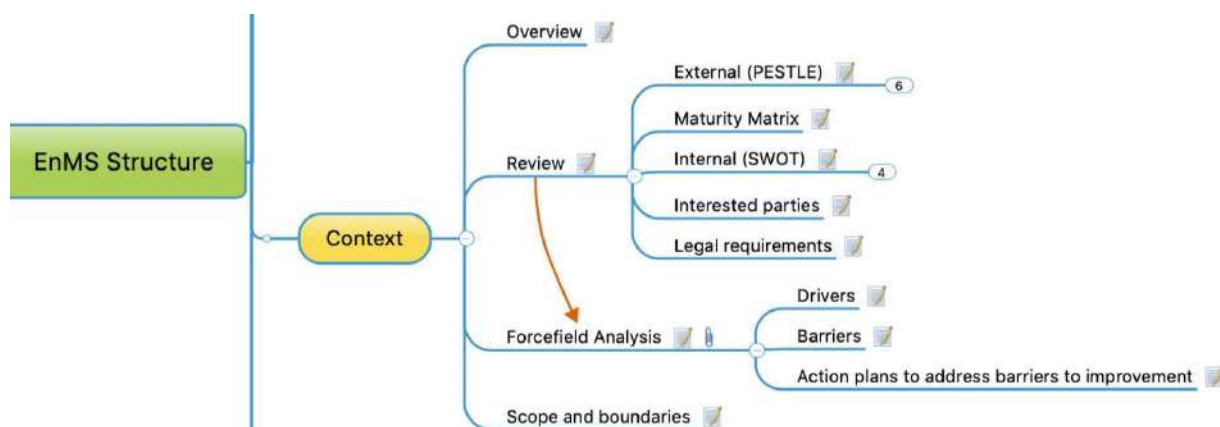
Is cost reduction the primary part of your context?

Is climate change important to your management?

Is energy part of your decarbonisation plans?

Identify and plan for risks and opportunities

69



70

External context: PESTLE analysis

- Political
 - What are the political decisions that are likely to affect your use of energy?
E.G., Carbon tax, SDGs.
- Economical
 - What might happen economically? E.G., rising energy prices
- Societal
 - Is society changing related to energy and green house gases (GHGs)?
- Technological
 - Are there technological changes that might help you?
- Legal
 - What are the laws that apply to your energy use?
- Environmental
 - Are there environmental issues? E.G., noise, pollution, GHGs.

71

Context:



UN Chief: Mobilize the world to make the next steps the right ones



Climate finance: Time to deliver

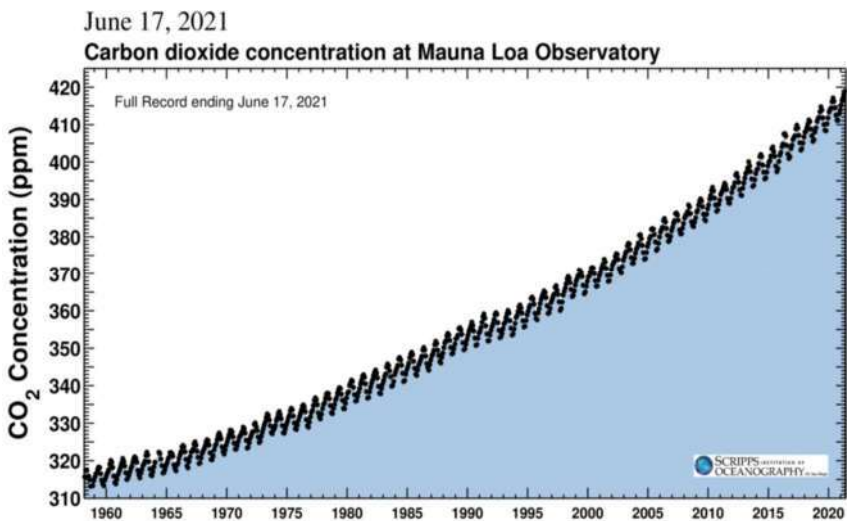
Source: UN

Prevention cuts drought costs

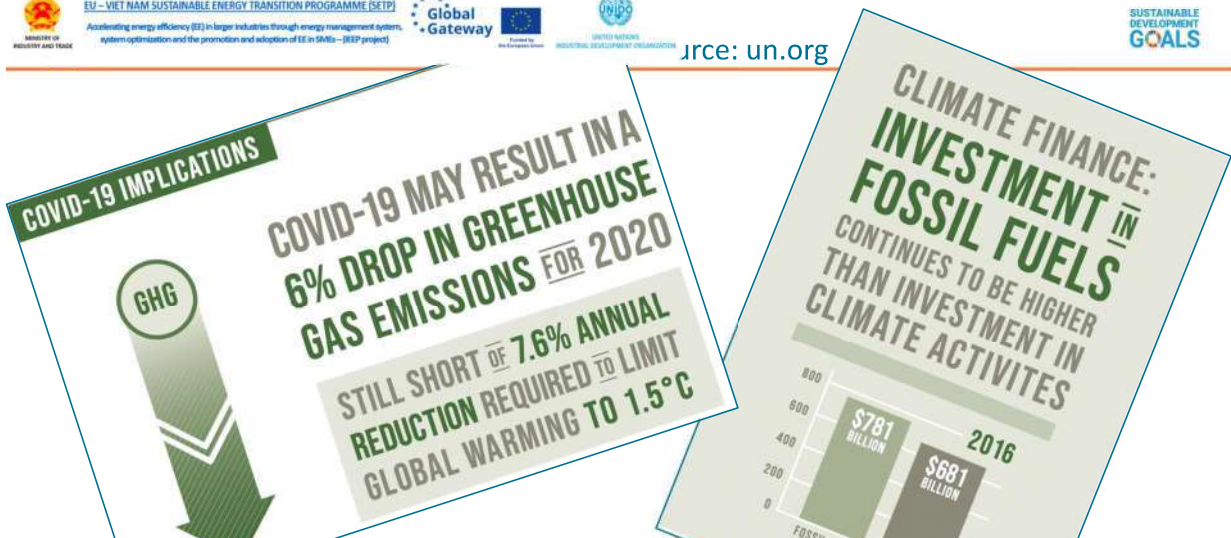
72

Context: Rising CO₂ concentration since 1960


Source: <https://keelingcurve.ucsd.edu>




Source: un.org




CLIMATE CHANGE CONTINUES TO EXACERBATE THE FREQUENCY AND SEVERITY OF NATURAL DISASTERS




MASSIVE WILDFIRES



DROUGHTS



HURRICANES

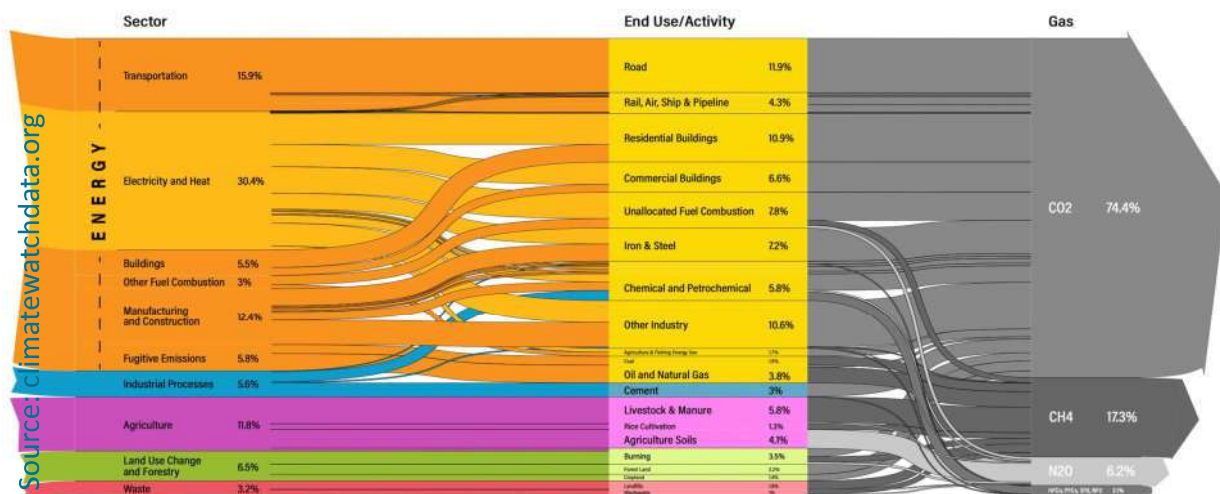


FLOODS

AFFECTING MORE THAN 39 MILLION PEOPLE IN 2018

World Greenhouse Gas Emissions in 2016

Total: 49.4 GtCO₂e



75

Internal Context: SWOT analysis

- **Strengths**
 - What strengths does your organisation have related to energy management? E.G. innovative, technical competence.
- **Weaknesses**
 - What weaknesses do you have? E.G. lack of technical knowledge, lack of leadership.
 - Your weaknesses will be a barrier to success
 - Overcoming them is a critical success factor
- **Opportunities**
 - What opportunities exist? These might come from PESTLE analysis.
- **Threats**
 - What threats are there to your organisation related to energy use? E.G rising energy costs. These might come from PESTLE analysis.

76

Interested parties

- Who is affected by your energy use or by your EnMS?
 - E.G. Suppliers, customers, neighbours, regulators, employees, society, management, HQ, etc.
- What are their needs and expectations?
 - How are each of them affected and what do they need from you?
- Which are relevant and require action?
- How will you meet these needs and expectations?
 - What will you do?

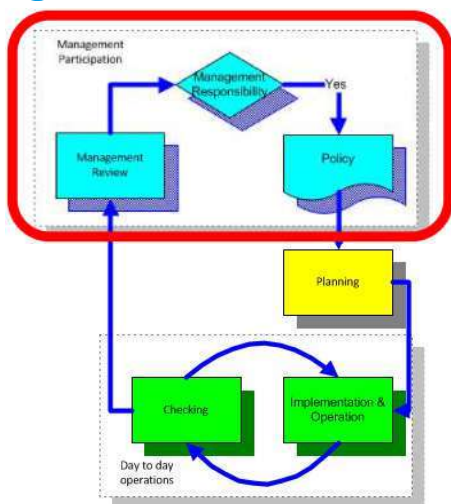
Some of the output will be “other requirements”

77

Management Commitment

78

Management's Role



- Without top management commitment, the EnMS will not succeed!
- Top management controls:
 - ✓ priorities
 - ✓ authorities
 - ✓ resources
- Top management must be engaged and visible!

79

The foundation of management commitment

- Management commitment begins with buy-in to the business value of a systematic approach to energy management
- Continued management commitment relies on continual refinement and communication of the business value of energy management
- Over time, the organization's own achievements and improvements will demonstrate the business value of energy management
- Need to consider the Context of the organization and the risks and opportunities associated with energy management.

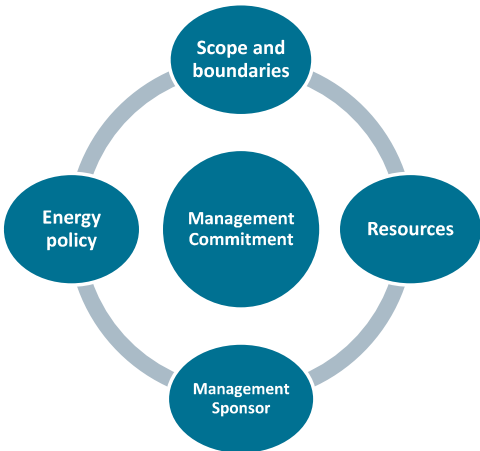
80

Organizational Reality

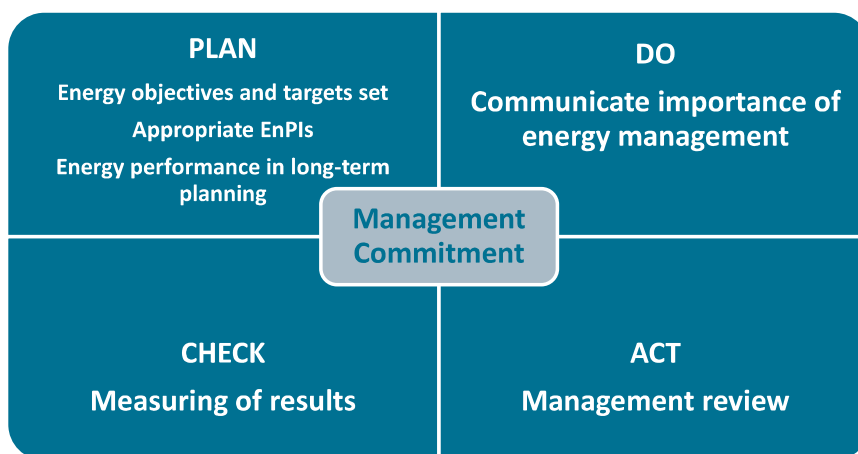


It is imperative that energy management goals flow through the management hierarchy from the top through middle management to the employee on the front lines, so that everyone has a clear understanding of their roles and responsibilities in achieving those goals.

Management Commitment Connections



Management Commitment Connections



83

How does top management demonstrate commitment?

- Understand the needs and expectations of interested parties
- Set the scope and boundaries of the EnMS
- Establish energy policy
- Allocate resources
- Appoint management representative
- Approve formation of energy management team
- Communicate importance of energy management
- Ensure objectives, targets, and appropriate ENPIs are established
- Consider energy performance in long-term planning
- Ensure measurement and reporting of results
- Conduct management reviews

84

What are the responsibilities of the Management Sponsor?

- Plan, implement and continually improve the EnMS
- Develop energy management team
- Report to top management on
 - energy performance
 - performance of the energy management system
- Make sure energy planning supports the energy policy
- Define and communicate responsibilities
- Determine how to ensure energy management system effectiveness
- Promote awareness across the organization

85

Reporting is key!

- Reporting is a key element in maintaining management commitment
- Ongoing communication of successes builds confidence and buy-in
- Clear, concise information on results makes best use of valuable management time
- Value-added information leads to informed decision-making



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Expert's Role in Management Commitment

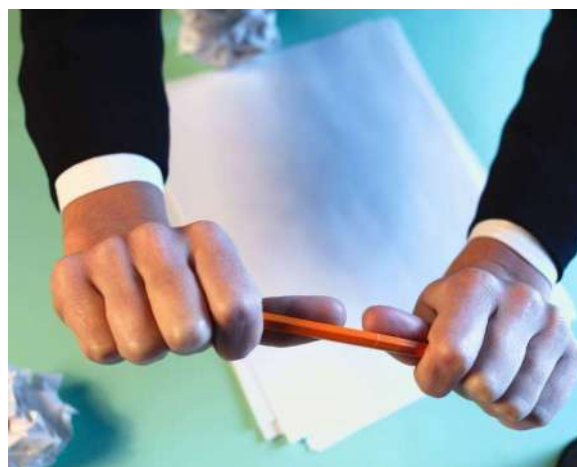
- Develop strategies for top management involvement and visibility
- Promote ongoing refinement and communication of the business case
- Mentor the management representative
- Ensure framework for reporting to management is established and implemented
- Implement management review as an action-based process



87

Typical Barriers

- Competing organizational priorities
- Resource constraints
- View of energy as overhead
- “We are already doing this?”
- “Not my job” mentality
- Information overload



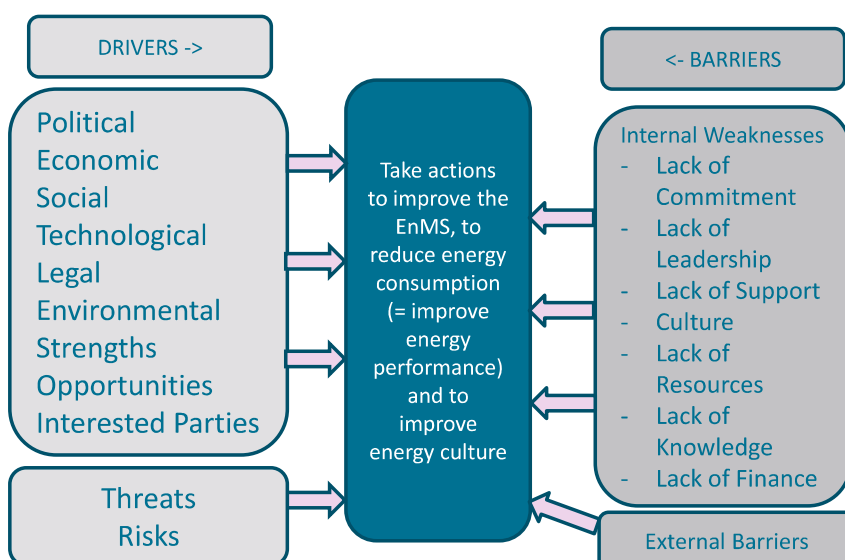
88

Value to the Organization

- Aligns energy management with organizational priorities
- Ensures long-term sustainability of the EnMS
- Encourages employee buy-in and participation
- Provides visible demonstration of environmental leadership to external parties



89



90

Exercise 3: Forcefield Analysis

- What are your drivers to improve energy performance?

Drivers and Opportunities	Importance	Plans to address opportunities	Responsible for opportunity plans	Target date	Implementation date
From PESTLE and SWOT analysis results, list the positive factors that will help to develop and effective EnMS. This will be P,E,S,T,L,E and S,O from SWOT.	How important is this factor in helping to develop the EnMS.	How will this opportunity be taken?	Who is responsible?	When will the plan be completed?	When was it actually completed?

Note: This exercise should be repeated with senior management within the organization.

91

See you in 15 minutes!



92

Scope and Boundaries

93

Scope and Boundaries

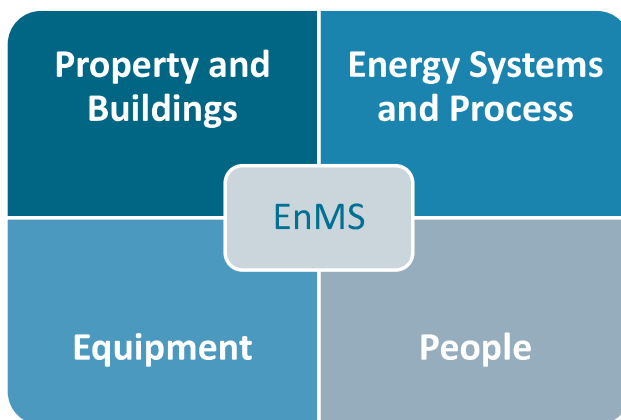
Scope and boundaries of the EnMS need to be

- **Defined**
- **Documented**



94

What Are You Including?



95

Is There Anything That is Not Included?

- Do you have a building or location that you are not including?
- Do you have a process or product line you are not including?
- Is there an area on which you do not have energy information?
- Is there an area where you cannot gain employee involvement or participation?
- Is there a different management team or decision structure?

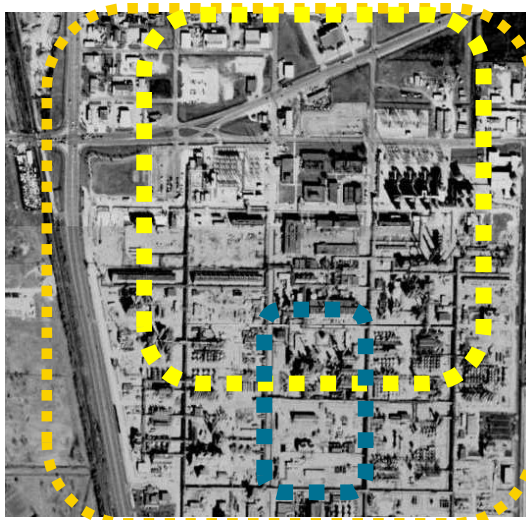
96



97

Scope and Boundaries

A clearly defined scope and boundary allows the organization to set clear expectations and properly focus their efforts



98

Scope and Boundaries

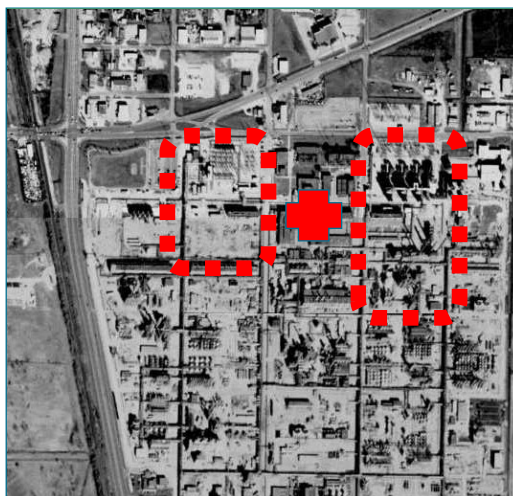
Boundaries may represent
separate physical spaces



99

Scope and Boundaries

Boundaries may represent
separate physical spaces that
are combined to be one Scope



100

The Expert's Role

- Ensure the scope and boundaries are defined and documented
- Review the EnMS as the program develops to ensure the scope and boundaries are represented
- Review the energy information available and ensure it covers the scope.
- If you do not have energy data you will need to carefully consider your boundaries.



101

Connections and Considerations

- Top management commitment
- Energy review covers the scope
- Competence awareness and training cover the scope of the system
- ☐ Were all energy sources considered?
- ☐ Were other relationships such as corporate purchasing addressed?
- ☐ Were other systems such as ISO 9001 & ISO 14001 considered?

102

Potential Barriers

- Existing management system only covers a part of the organization.
- Corporate controls certain functions such as purchasing, or design.
- Limited energy data.

Value to the organization

- ✓ Allows the organization to focus their efforts
- ✓ Allows the organization to focus their resources
- ✓ Allows the organization to clearly communicate the expectations

103

Actions, Documents and Records

- ❖ Review the organizational goals
- ❖ Review the organizational boundaries
- ❖ Define the organizational EnMS scope
- ❖ Document the scope and boundaries of the EnMS
- ❖ Load the scope and boundaries to the website

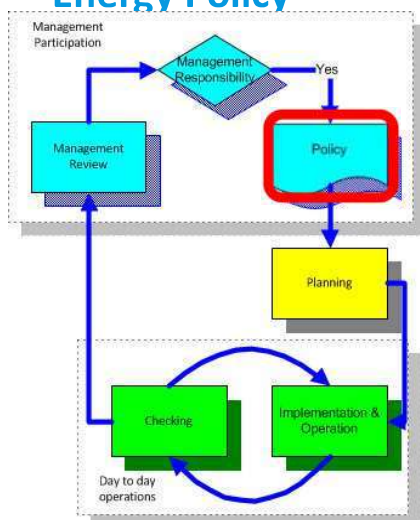


104

Energy Policy

105

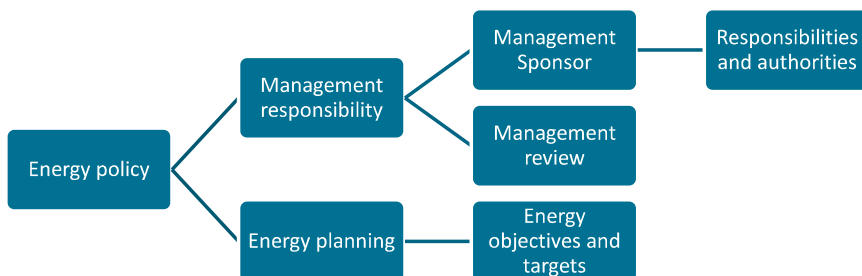
Energy Policy



- **System Driver**
 - Management commitment
 - Legal and other compliance
 - Energy performance improvement
 - Energy objectives and targets
- **System Check**
 - Energy planning
 - Training and communication
 - Operational controls
 - Procurement and design
 - Management review

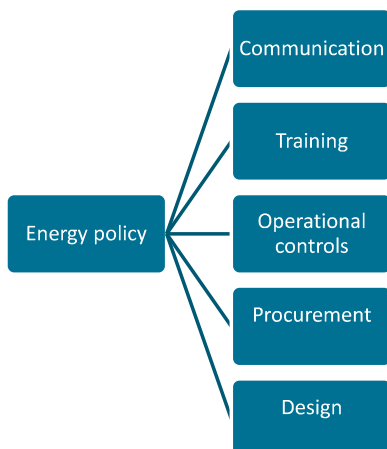
106

Policy Connections



107

Policy Connections



108

Energy Policy

States the commitment of the organization to:

- Continual energy performance improvement
- Availability of information and resources to achieve objectives and targets
- Compliance with legal and other energy requirements

Supports the commitment to:

- ☐ Purchase of energy-efficient products and services
- ☐ Consideration of energy performance improvement in design



109

Energy policy basics

- ❖ Defined and approved by top management
- ❖ Appropriate for the organization
- ❖ Provides the framework for objectives and targets
- ❖ Documented
- ❖ Communicated
- ❖ Regularly reviewed
- ❖ Updated as needed

110

Example XYZ Company Energy Policy

- As an energy intense manufacturer of specialty glass, XYZ Company strives to reduce its energy consumption and costs and promote the long-term environmental and economic sustainability of its operations. We are committed to:
- **R**educe energy use per unit of production by 25% in 10 years in our manufacturing operations
- **E**nsure continual improvement in our energy performance
- **D**eploy information and resources to achieve our objectives and targets
- **U**phold legal and other requirements regarding energy
- **C**onsider energy performance improvements in design and modification of our facilities, equipment, systems and processes
- **E**ffectively procure and utilize energy-efficient products and services

111

Drafting the Policy

- The policy can be a stand alone document or integrated with existing policies
- Consider a working draft from implementation team and senior management for top management consideration
- Ensure policy is appropriate to your organizational culture and to all levels
 - Promote initial discussion
 - Collect viewpoints

112

Communicating the Policy

- Integral part of a management system awareness and communication program—First piece of the EnMS that the whole organization is exposed to
- Post the policy throughout your facilities/work sites, incorporate in trainings, place on intranet, etc.
- Be creative in communication: backs of ID tags, on hard hats, in annual report, websites, paycheck stuffers, etc.
- Plan for how the policy will be communicated to part-time and temporary employees and to contractors and suppliers working on your site.

113

Expert's Role in the Energy Policy

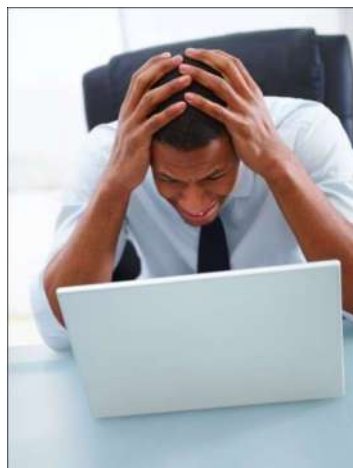
- Check for existing energy, environmental or sustainability policies
- Set a timetable for policy development and implementation
- Provide strategies for ensuring employee understanding of the policy
- Ensure the connections to the EnMS are made as the policy is implemented



114

Typical Barriers

- Too lengthy or complicated
- Too many levels of management approval
- Resistance to integrating the energy policy with other management system policies



115

Success Factors

- Aligned with other organizational policies
- States required commitments
- Minimizes additional commitments
- A policy that is easy to remember and understand
 - Sometimes mnemonics are used
 - One page or less – one paragraph or less would be better!



116

Value to the Organization

- Visible statement of top management commitment
- Sets strategic direction
- Establishes energy as a priority
- Communicates energy performance commitments
- Supports sustainability



117

Deliverables

- Develop the energy policy



118

Exercise 05: Develop Energy Policy

- Review the ABC Company Quality and Environmental Policy
- ABC Company has decided to integrate its energy policy with its existing Quality and Environmental Policy.
- Revise the ABC Company Quality and Environmental Policy to include the required commitments of an energy policy.

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**Day 1 End
Thank You**

120

Energy Management System (EnMS) Expert Training

UNIDO International Energy Efficiency and EnMS Training

Module 1 Day 2

Delivered by: Richard Morrison, Stefan Walta

1

Housekeeping

Emergency Exits
Toilets
Mobile Phones
Breaks
Lunch
Please restrict email to
break times
Interact and ask questions



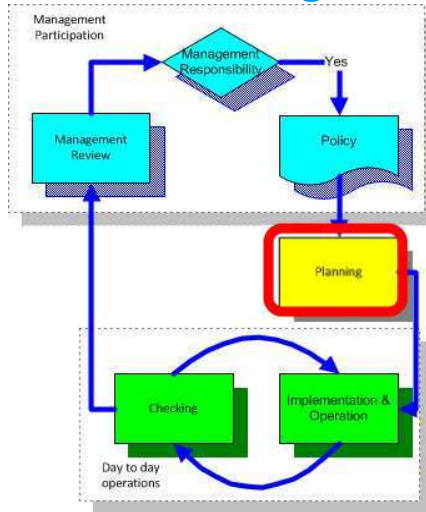
2

Today

Start Time	End Time	TOPIC	DURATION (min)	EXERCISE (min)
08:30	08:45	ENERGY MANAGEMENT PLANNING PROCESS	15	
08:45	09:30	LEGAL AND OTHER REQUIREMENTS	25	
		* Exercise 06: Legal & Other		20
09:30	10:00	ENERGY REVIEW - Part 1	15	
		* Exercise 07A: Evaluate energy consumption		15
10:00	10:15	BREAK	15	
10:15	12:00	ENERGY REVIEW - Part 2	60	
		* Exercise 07B: Energy Balance & SEUs		45
12:00	13:30	LUNCH	90	
13:30	15:00	ENERGY REVIEW - Part 3	60	
		* Exercise 07C: Energy Opportunities		30
15:00	15:15	BREAK	15	
15:15	16:45	ENERGY PERFORMANCE & CALCULATING ENERGY SAVINGS	60	
		* Exercise 08: Calculate Energy Savings		30
16:45	17:00	Daily Wrap Up	15	

Energy Management Planning Process

Planning



- How much energy am I using?
- Where am I using it?
- What Legal requirements are related to my energy use?
- What Other requirements are related to my energy use?
- Which are significant users?
- What is driving it?
- Who is influencing its use?
- Do I need to have an energy audit?
- System Optimization
- Renewable energy options
- Are there legal or other requirements?
- Develop baseline & indicators
- Set objectives and targets
- Action Plans

5

Introduction

- Detailed look at the planning part of an EnMS
- This is the set up of the main part of your system
- Remember the purpose is to improve energy performance, i.e. to save energy

6

What is planning?

We have a policy with management support, resources,
strategic direction and committed team members

We now want to translate this policy into an

action plan

for improved energy performance

7

Energy Planning

Legal and other
requirements

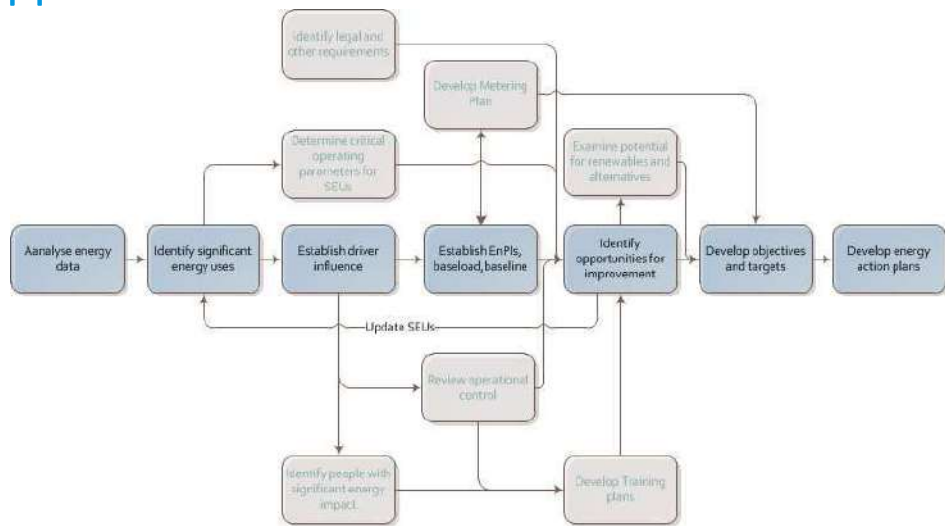
Energy
Review

Energy
Performance
Metrics

Objectives,
Targets &
Action Plans

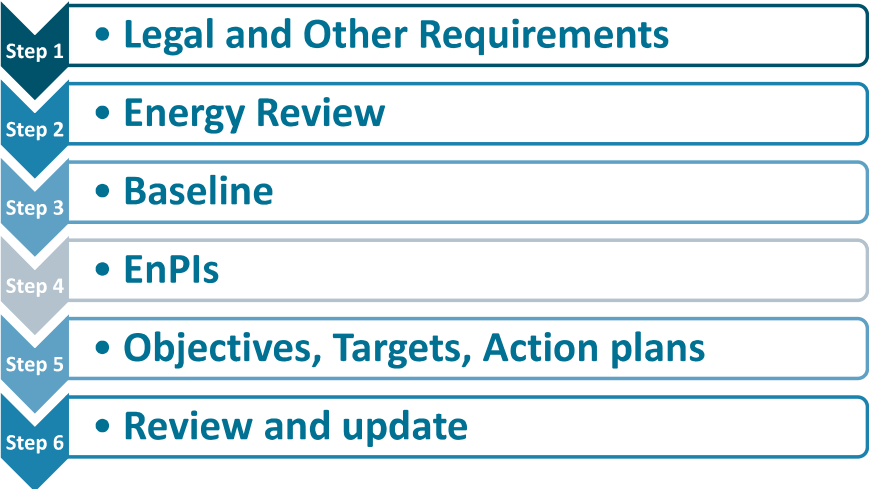
8

Develop plans – core workflow



9

Planning process



10

Legal and Other Requirements

11

WHAT THE EnMS MANAGES



**LEGAL REQUIREMENTS
AND
OTHER
REQUIREMENTS**



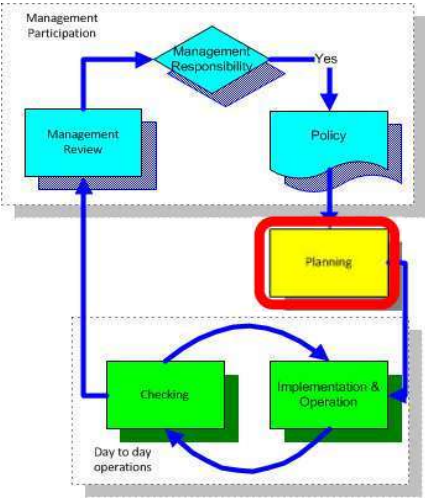
**SIGNIFICANT ENERGY
USES**



**ENERGY
PERFORMANCE
IMPROVEMENTS**

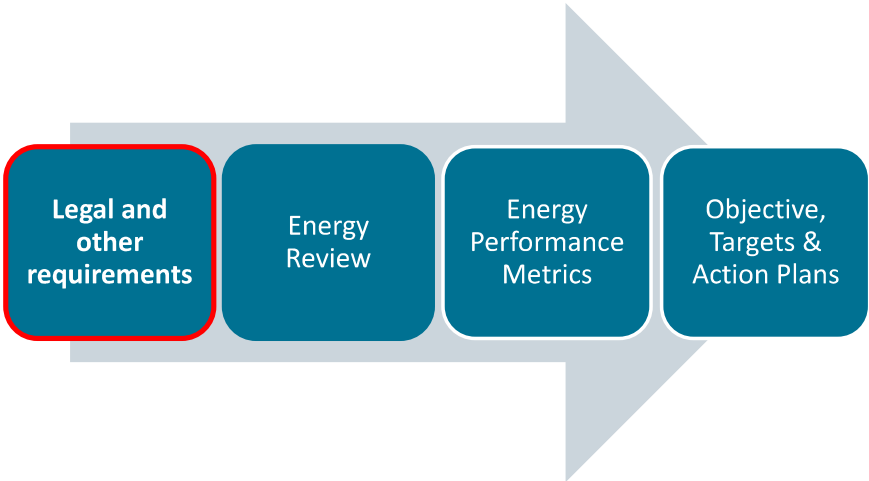
12

Planning

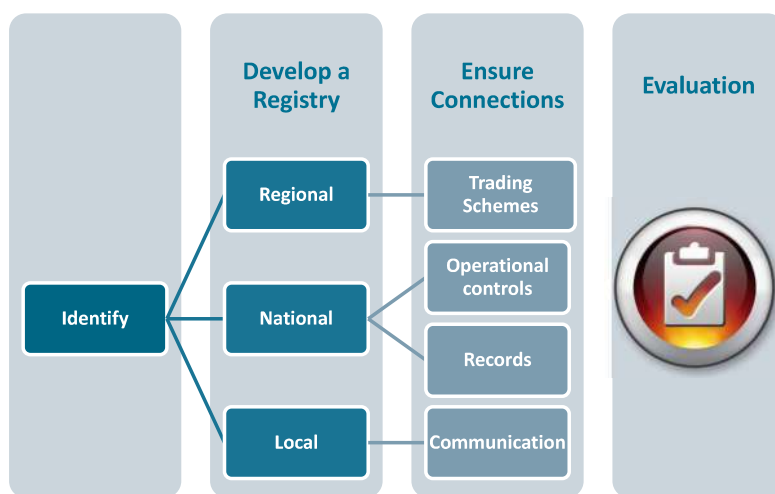


- How much energy am I using?
- Where am I using it?
- Which are significant users?
- What is driving it?
- Who is influencing its use?
- Do I need to have an energy assessment (=audit)?
If yes, focus it
- **System Optimization**
- Renewable energy options
- Are there legal or other requirements?
- Develop baselines & EnPIs
- Set objectives and targets
- Action Plan

Planning



Legal requirements



15

Examples

- Energy Act 2008, National Energy Efficiency Strategy and the Renewable
- Strategy : For Mining and Industry: A Target Final Energy Demand Reduction of 15% by 2015
- The Department of Environmental Affairs looking at GHG emission targets (already there is an emissions tax on new vehicles)
- The DOE (in progress or under consideration)
- regulations around energy management plans (including energy management opportunities/projects and self-imposed savings targets for large users),
- the reporting of energy consumption data to the DOE annually,
- a provision for measures to be adopted in the event of energy shortage,
- a mandatory standard on EE motors and appliance labelling for household appliances etc

Source: South Africa

16

Exercise 06: Registry with Connections

- Regulation title with a brief description or the Other requirement with a brief description
- Reference
- Who is responsible
- How often is it reviewed
- What operations/processes/equipment are affected
- What persons are affected
- What records or documents are needed
- What training is required
- What communication is needed
- Evaluation of requirement (Checking connection)

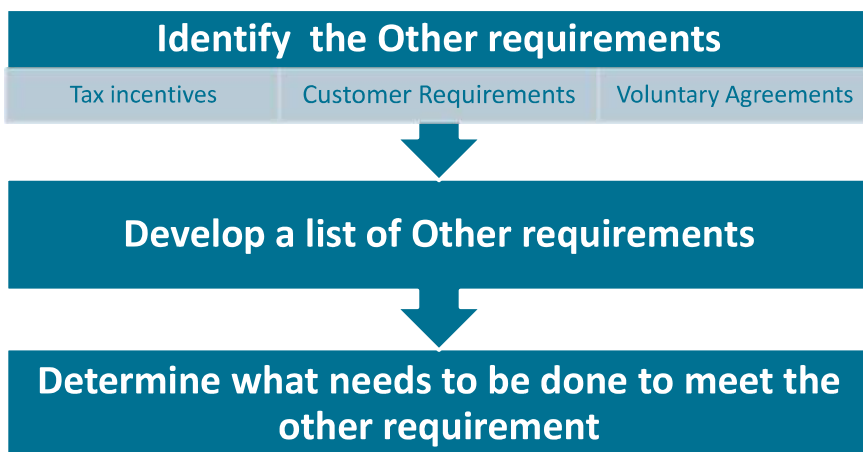
Exercise 06: Registry with Connections

Practical Guide for
Implementing an Energy Management System

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Energy Management System Tools											
Legal											
ID	Title of requirement	Reference	Category	Date identified	Relevant (y/n)	What is affected by this requirement?	What action is required	Resp	Reqd date	How often will this be reviewed	Does it require further action?
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											

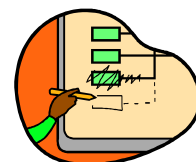
Other requirements



19

When Things Change

- Remember - when activities, equipment, or processes change, legal and other requirements need to be checked!
- Recognize relationship between regulated activity process owners and requirements
- When management changes review priorities and organizational commitments



20

Expert Role in Legal requirements and Other requirements

- Set a timetable for the identification to be completed
- Review the current status of the legal and other requirements identified
- Ensure the connections to the EnMS are made as the system is implemented
- See if there is an existing process that you can leverage such as ISO 14001



21

Typical Barriers

- Knowledge of the process
- Knowledge of the regulations
- Knowledge of the organizational commitments
- Requirements not currently implemented



22

Value to the Organization

- Clear understanding of regulatory requirements
- Clear understanding of and related penalties/costs for non-compliance
- Registry of legal requirements and other requirements for use
- Evaluation records of legal requirements
- Clear accountabilities
- Clear communication



23

Actions, Documents and Records

- Review the National, Regional and local legal requirements
- Review the organization' s other commitments
- Develop the registry of legal and other requirements
- Complete the table for requirements and connections
- Plan for the evaluation of legal requirements and other requirements
- Load the registry to the website

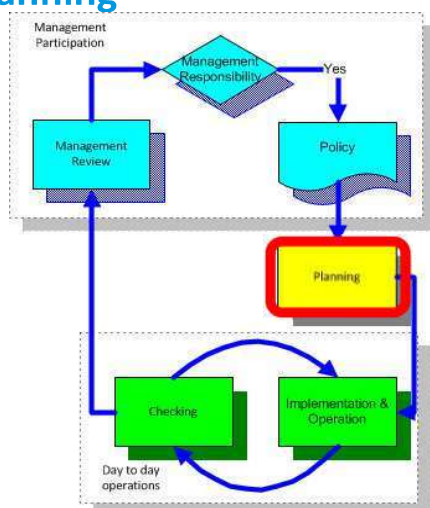


24

Energy Review

25

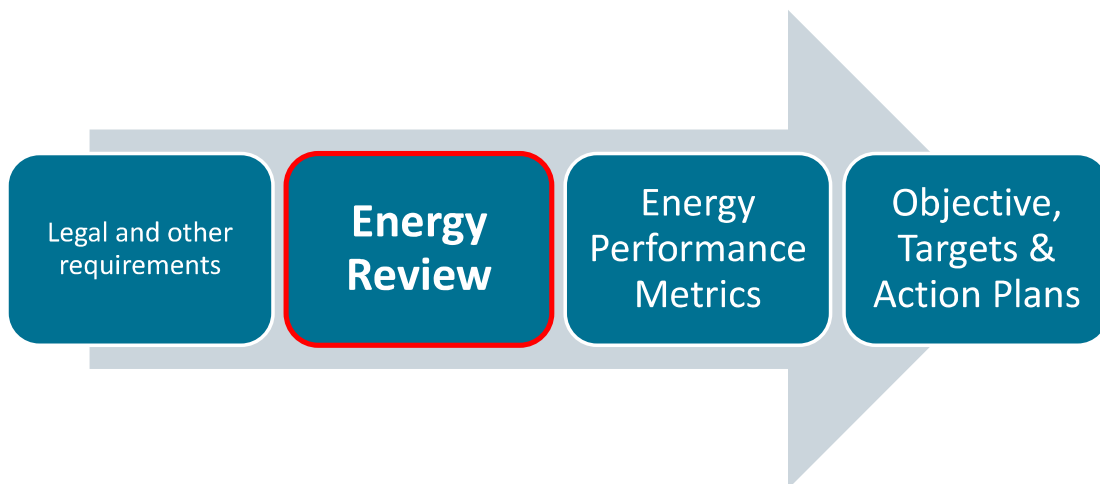
Planning



- How much energy am I using?
- Where am I using it?
- Which are significant users?
- What is driving it?
- Who is influencing its use?
- Are there opportunities for improvement?
- What is my future energy picture?
- Renewable energy options
- Are there legal or other requirements?
- Develop baseline & indicators
- Set objectives and targets
- Action Plans

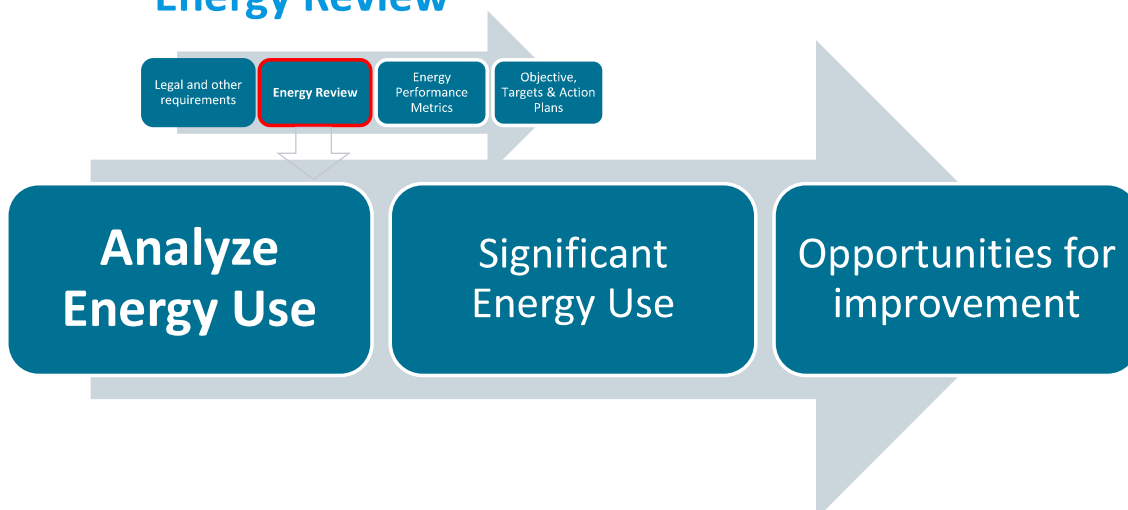
26

Planning



27

Energy Review



28

What are my energy sources, uses and consumption levels?

- Electrical, natural gas, propane, hydro, wind?
- What facilities, systems or equipment are using energy?
- What data do we have and where/how can we get it?
- What data do we need and where/how can we get it?
- How much energy are we using?
- How much did we use in the past?
- What are energy predictions for the future?
- What are the trends?
- Where do we stand against benchmarks?

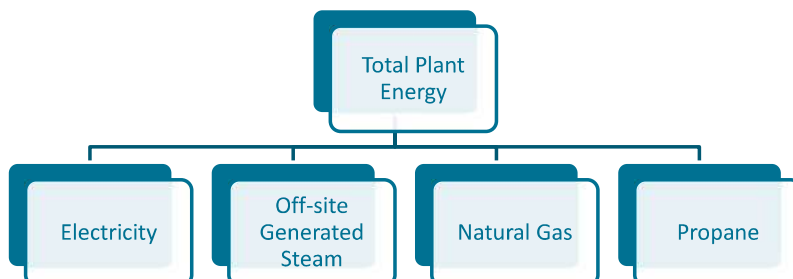
29

Analyze Energy Use & Consumption

- Collect past and current monthly consumption data at the facility level (energy bills)
- Determine what other data may be available for analysis
 - Sub-meter data
 - Interval data
 - Equipment information
 - Other data
- Determine PAST and CURRENT energy consumption by use
- Note: The time period for data collected will depend on your organization and what data is available.

30

Identify all energy sources that cross the boundary as identified on Day 1



Utilize flow charts to assist in the energy sources identification

31

Analyze Energy Consumption

Meter readings for main building

Electricity Meter #3

Account ID 129 Location Main Building PPD 62000
Account Number 30-872-086 Building 0054

Billing Period	Days	kWh	per Day	Peak kW	Amount	Cost per Day
FY 2006						
6/30/05 - 7/27/05	27	352,000	13,037	680	\$17,600	\$651.85
7/27/05 - 8/30/05	34	380,000	11,176	720	\$19,000	\$558.82
8/30/05 - 9/28/05	29	373,200	12,869	720	\$18,660	\$643.45
9/28/05 - 10/28/05	30	296,000	9,867	640	\$14,800	\$493.33
10/28/05 - 11/29/05	32	336,000	10,500	600	\$16,800	\$525.00
11/29/05 - 1/3/06	35	283,600	8,103	880	\$14,180	\$405.14
1/3/06 - 1/30/06	27	271,600	10,059	680	\$13,580	\$502.96
1/30/06 - 2/28/06	29	284,000	9,793	720	\$14,200	\$489.66
2/28/06 - 3/30/06	30	322,800	10,760	680	\$16,140	\$538.00
3/30/06 - 4/27/06	28	318,000	11,357	680	\$15,900	\$567.86
4/27/06 - 5/30/06	33	348,400	10,558	640	\$17,420	\$527.88
5/30/06 - 6/13/06	14	140,800	10,057	600	\$7,040	\$502.86
Total		3,706,400	10,651		\$185,320	\$532.53

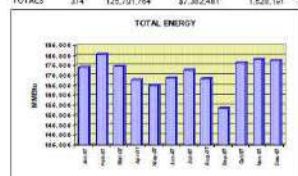
32

Analyze Energy Consumption

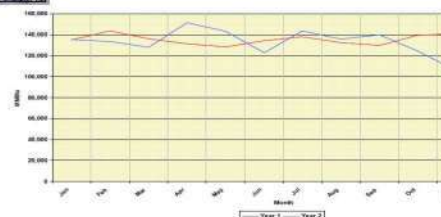


FACILITY UTILITY SUMMARY REPORT Main Plant

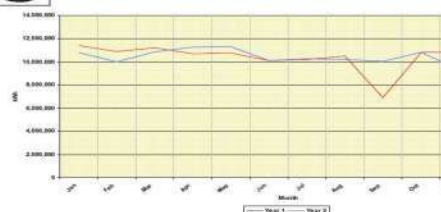
MONTH	DAYS	ELECTRICITY USE (KWH)	ELECTRICITY COST (\$)	FOSSIL FUEL USE (MMBTU)	FOSSIL FUEL COST (\$)	WATER USE (GAL)	WATER COST (\$)	TOTAL ENERGY (MMBTU)	TOTAL UTILITY COST (\$)	AVG. COST (\$/MMBTU)
JAN 2007	48	11,452,762	\$362,977	185,197	\$1,227,912	3	\$0	176,398	\$1,629,989	\$9.25
FEB 2007	28	10,897,891	\$340,227	143,456	\$959,242	3	\$0	162,847	\$1,349,469	\$8.30
MAR 2007	31	11,353,850	\$418,314	156,261	\$994,054	3	\$0	174,899	\$1,412,368	\$8.18
APR 2007	31	10,567,386	\$340,344	151,321	\$933,030	3	\$0	167,748	\$1,473,374	\$8.80
MAY 2007	31	10,719,284	\$476,237	128,284	\$868,961	3	\$0	164,367	\$1,442,119	\$8.64
JUN 2007	29	10,597,321	\$634,689	134,281	\$1,048,940	3	\$0	168,752	\$1,683,629	\$9.59
JUL 2007	31	12,102,310	\$935,495	137,979	\$1,053,094	3	\$0	172,724	\$1,917,569	\$9.49
AUG 2007	29	10,448,478	\$695,520	151,936	\$947,720	3	\$0	168,319	\$1,643,242	\$9.79
SEP 2007	30	9,918,279	\$420,310	129,021	\$795,411	3	\$0	153,385	\$1,215,721	\$7.90
OCT 2007	31	10,798,886	\$543,333	139,452	\$847,030	3	\$0	170,341	\$1,390,363	\$8.32
NOV 2007	29	10,817,837	\$666,786	147,137	\$1,173,901	3	\$0	176,367	\$1,840,687	\$10.34
DEC 2007	31	11,918,285	\$791,620	186,284	\$1,253,652	3	\$0	177,669	\$1,975,282	\$11.12
TOTALS	374	125,791,764	\$7,362,481	1,529,191	\$11,724,014	0	\$0	2,057,065	\$19,106,495	\$9.29



MAIN PLANT FOSSIL FUEL CONSUMPTION JAN 2006 - DEC 2007



MAIN PLANT ELECTRICITY CONSUMPTION JAN 2006 - DEC 2007



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Utility Account Reports



ELECTRICITY ACCOUNT REPORT EL_RTP#2

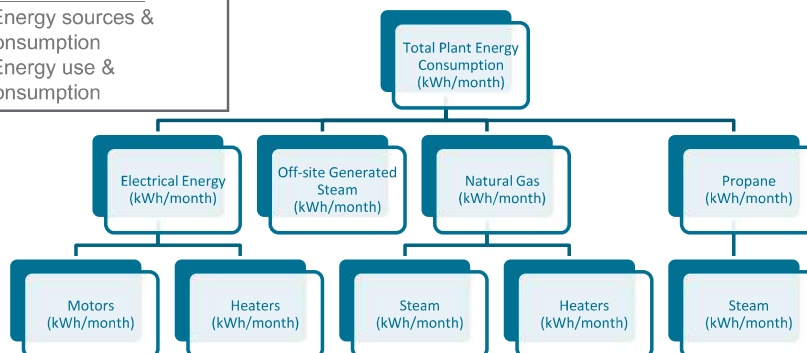
MONTH	DAYS	BASE KWH	RTP KWH	ACTUAL DEMAND	BILLING DEMAND	BASE KWH COST	RTP KWH COST	TOTAL COST	#KWH	COST PER DAY
JAN 2007	30	3,243,112	444,032	5,939	0	\$175,747	\$18,270	\$200,352	5,993	\$6,688
FEB 2007	28	2,895,851	845,871	5,934	0	\$165,872	\$27,214	\$200,710	5,917	\$7,393
MAR 2007	31	3,176,177	363,803	5,823	0	\$185,888	\$16,046	\$205,426	6,726	\$4,988
APR 2007	30	2,806,747	105,027	5,682	0	\$187,030	\$5,070	\$211,402	6,771	\$7,393
MAY 2007	31	3,114,284	881,416	5,942	0	\$182,689	\$18,042	\$215,361	6,666	\$7,319
JUN 2007	29	3,162,713	474,643	6,773	0	\$203,664	\$6,263	\$209,184	6,370	\$7,197
JUL 2007	31	3,902,118	145,868	5,918	0	\$229,324	\$5,342	\$234,144	6,149	\$7,471
AUG 2007	31	3,948,068	445,468	5,930	0	\$239,192	\$6,410	\$239,325	6,319	\$8,444
SEP 2007	31	3,102,399	258,211	5,970	0	\$0	\$0	\$200,944	5,912	\$6,772
OCT 2007	31	3,101,808	892,288	5,928	0	\$0	\$230,894	\$9,944	6,789	\$7,899
NOV 2007	31	3,207,898	623,305	5,979	0	\$0	\$247,665	\$6,635	6,779	\$7,879
TOTALS	920	38,681,146	2,705,684			\$1,493,485	\$80,411	\$2,376,555	5,896	\$7,255



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Analyze Energy Use

Utilize flow charts
•Energy sources &
consumption
•Energy use &
consumption



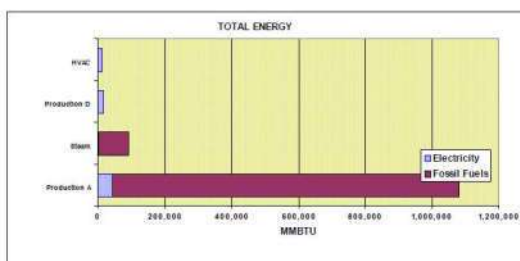
35

Analyze Energy Use



ENERGY BALANCE REPORT Main Plant

SYSTEM	ELECTRICITY MMBTU		FOSSIL FUEL MMBTU		TOTAL MMBTU	
HVAC	10,081	4.2%	0	0.0%	10,081	0.6%
Production A	45,021	18.7%	1,034,582	74.8%	1,079,603	66.5%
Production D	17,696	7.3%	186	0.0%	17,884	1.1%
Steam	2,973	1.2%	87,963	6.4%	90,936	5.6%
Other	165,623	68.6%	260,346	18.8%	425,969	26.2%
TOTAL	241,396		1,363,097		1,624,492	



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Expert's Role in Energy Use

- Aid the facility in collecting high level data on each energy source
- Collect past and current monthly consumption data at the facility level (energy bills)
- Determine what other data may be available for analysis
 - Sub-meter data
 - Interval data
 - Equipment information
 - Other data

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Expert's Role in Energy Use

- Assist the facility in determining PAST and CURRENT energy consumption by use
- Help the facility determine the appropriate period for analysis
- Help facility analyze data for trends, drivers affecting energy use, comparison to benchmarks, potential problems, etc.

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Typical Barriers

- Lack of data
- Production and energy data on different time frames
- Lack of metering
- Meters not calibrated
- Data not organized for analysis
- Notion that energy data not important to equipment operation



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Value to the Organisation

Analysis of Past and Present Data

- Identifies most costly uses
- Identifies trends
- Highlights problems early
- Forms basis for comparison
- Used to evaluate progress



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Deliverables

- Energy Review – Gather current energy data
- Energy Review – Locate & secure past energy data
- Criteria and methods used to locate, collect, organize and analyze energy data
- Energy data



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Exercise 07A – Evaluate energy consumption

- Discuss how many different energy sources your company has.
- Enter available utility data and information into the billing worksheet; is there any utility data missing?
- Review graphs of utility data; what are the energy consumption trends. Why?
- Calculate unit energy cost for electricity and all other fuels.
- Convert energy consumption data into a common unit (kWh or GJ); which energy source is the most expensive per unit?
-

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See you in 15 minutes!



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Energy Review

Analyze Energy
Use

Significant
Energy Use

Opportunities
for
improvement

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Significant Energy Uses

- Significant component of the organization consumption
- Equipment, processes, facilities, systems
- Considerable opportunity for improvement
- Determined by organization!
- Document methods and criteria



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Significant Energy Uses

- Identify parts of the organization that can significantly affect energy use and consumption and determine current performance
 - Facilities
 - Equipment
 - Systems
 - Processes
 - Personnel working for or on behalf of the organization
- Determine relevant variables affecting significant energy uses and consumption.
- Estimate future energy consumption and use

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Significant Energy Use Identification

- Use facility and process flow diagrams to identify energy uses and interactions
- Show primary and secondary energy streams
- Use previously collected data to determine energy use
- Is additional data required?
- Group equipment and processes into logical systems
- Which people affect the energy use of that item/system?

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How to quantify each energy user

- Do you have sub-metering?
 - Automatically logged to a database
 - Manual readings
 - Meters accurate and working
 - Data collection process working, consistent and accurate
- Do you have local meters?
 - These can be read manually and calculated/estimated
 - Care with time of readings
- Motor List, Heat Balance, Sankey Diagram
- Ideally identify at least 80% of energy use
- SEU list is the basis of much of the EnMS



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Motor List

ID	Purpose	Name plate (kW)	Hours per year	Ave VSD speed (100% if fixed)	% name plate load	Actual Power (kW)	Annual Power (kWh)	Note	When can this be switched off?	% of total	How were estimates made?	Opportunities for improvement	SEU
1	Cooling Water Pump #1	20	4200	0.5	0.9	4.5	18,900	shares load with #2		0.0189	Hours run meter reading, estimate of speed, estimate of nameplate %	insert ref nos from opp list	Cooling water
2	Cooling Water Pump #2	20	4200	1	0.9	18	75,600			0.0756	Hours run meter reading, estimate of speed, estimate of nameplate %		Cooling water
3	Hydraulic pack drive	100	250	1	0.9	90	22,500	used intermittently		0.0225	Hours run meter reading, estimate of speed, estimate of nameplate %		Production
4	Seal cooler pump	1	8400	1	0.9	0.9	7,560		almost always	0.00756	review of operator logs, estimate of speed, estimate of nameplate %		Production
5	AHU 1 Fan	10	8400	0.8	0.9	5.76	48,384		night and weekend	0.048384	review of BEMS data, other items estimated		HVAC
6				1	0.9	0	-			0			
7				1	0.9	0	-			0			
8				1	0.9	0	-			0			

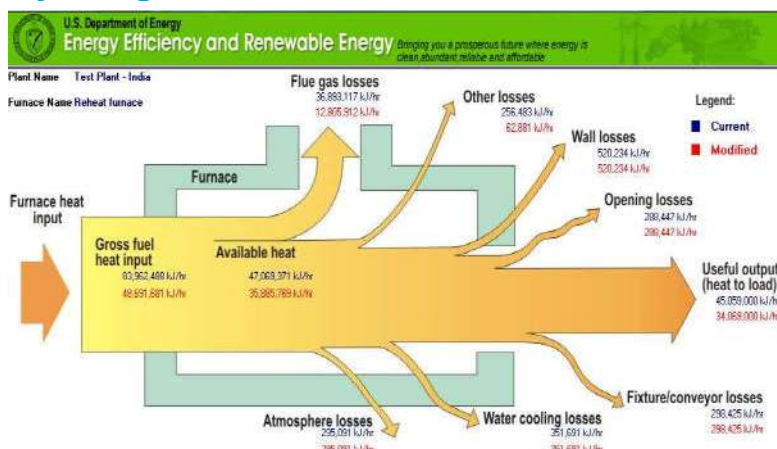
Use the UNIDO tools ER3 tab to assist

Heat (energy) balance

- Use what you know:
 - Steam flow
 - Feedwater flow (= steam flow approximately)
 - Fuel flow (heat flow = fuel flow * efficiency)
 - Gas bills
 - Hot water flow and temperature difference (dT) ($Q=m \cdot C_p \cdot dT$)
- Build up a balance
 - Heat in = heat out
 - If you have a significant gap, you may need to measure it
 - Ultrasonic flow meters, portable heat meters
- More challenging than electrical power
 - Typically fewer measuring points



SEU Sankey Diagram



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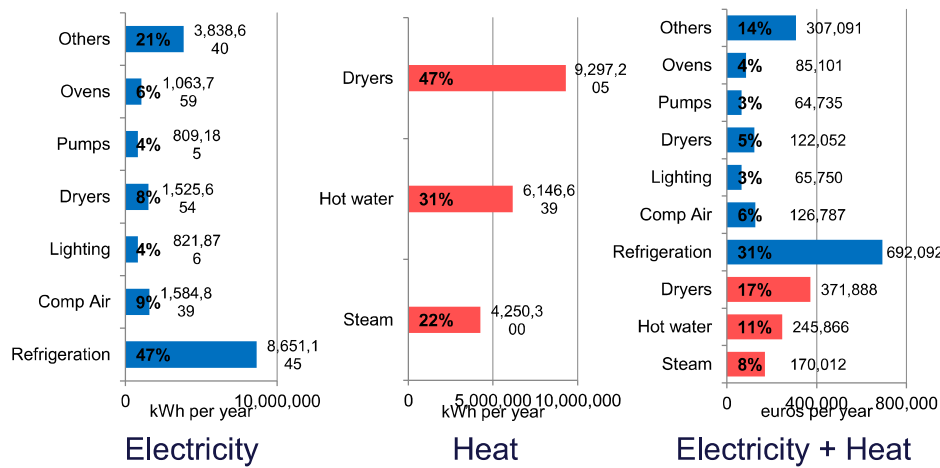
Significant Energy Use Identification

- Organize data in energy balance or other method to identify equipment and processes
- Use internal knowledge to add to list
- Techniques
 - Energy balance
 - Ranking methods
 - Six sigma tools
 - Other data analyses
- Remember Pareto Rule (80/20)
- **Start with a few**



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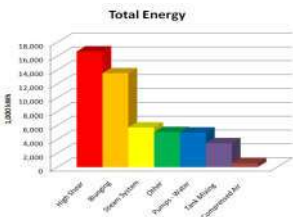
Significant Energy Uses (SEU)



Significant Energy Uses (SEU)

ENERGY BALANCE REPORT

SYSTEM	ELECTRICITY		FOSSIL FUEL		TOTAL	
	1,000 kWh		1,000 kWh		1,000 kWh	
Blunging	13,541	30.6%	0	0.0%	13,541	27.1%
Compressed Air	567	1.3%	0	0.0%	567	1.1%
Steam System	53	0.1%	5,673	97.6%	5,726	11.4%
Tank Mixing	3,449	7.8%	0	0.0%	3,449	6.9%
High Shear	16,677	37.7%	0	0.0%	16,677	33.3%
Pumps - Water	4,999	11.3%	0	0.0%	4,999	10.0%
Other	4,934	11.2%	138	2.4%	5,072	10.1%
TOTAL	44,220		5,811		50,031	



Rank Uses

Description	kW	%	Annual \$
Melter	9,634	53.4%	\$2,959,879
Hi Press Air Compressor	2,330	12.9%	\$715,852
Med Press Air Compressor	780	4.3%	\$239,641
Med Freq.	545	3.0%	\$167,442
Forming Fans	494	2.7%	\$151,773
Oven Scrubber	450	2.5%	\$138,255
Scrubber	414	2.3%	\$127,194
Cooling Water	407	2.3%	\$125,044
Filtered Air	373	0.0%	\$114,598
Fans	336	1.9%	\$103,230
Med Freq	320	1.8%	\$98,314
East Scrubber	255	1.4%	\$78,344
Forming Fans	150	0.8%	\$46,085
F. Fans West 4,5	122	0.7%	\$37,482
Line Drive	69	0.4%	\$21,199
Other loads and misc.	1,241	6.9%	\$381,276
100% Load Factor kW	18,042	100.0%	<u>\$5,543,090</u>

66% of total load

Another Method to Determine Significance

Criteria	Rating Description			
	1	2	3	4
Percentage of total plant energy consumption	0-10%	11-25%	26-50%	51-100%
Value of anticipated opportunity	Less than \$10,000/year	\$10,000-\$25,000/year	\$25,000-\$100,000/year	Greater than \$100,000/year

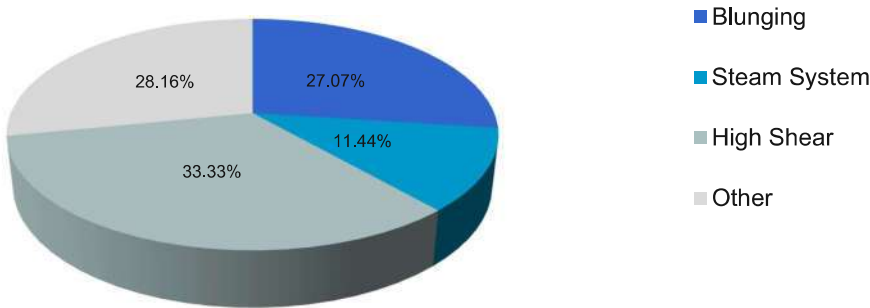
SEU List

- Develop list in order of magnitude of energy use
- Identify variables that affect energy use
- Determine performance of systems related to significant energy uses
- Identify systems with potential savings opportunities
- Track and analyze
- Prioritize by selected method

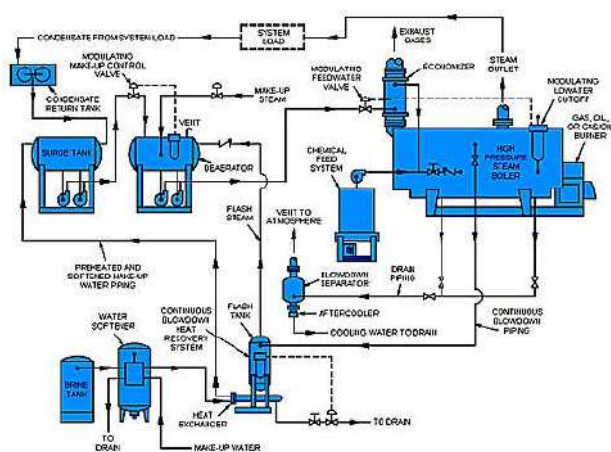


SEU Pie Chart

Significant Energy Uses For Mining Operation



Simple Steam System



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Steam System Perspective

A profile of losses operating a 5000 kW boiler with NG at 60% firing rate (annual fuel bill = \$800,000)

Boiler Losses		
Stack Losses	18%	\$144,000
Blowdown Losses	4%	\$ 32,000
Surface Losses	3%	\$ 24,000
	28%	\$200,000
Distribution System Losses		
Insulation Losses	7%	\$ 56,000
Steam Leaks	6%	\$ 48,000
Blowing Traps	5%	\$ 40,000
Flash Losses	11%	\$ 88,000
Return Losses	9%	\$ 72,000
	38%	\$304,000

Combined Losses	66%	\$504,000
System Efficiency	34%	\$296,000

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Connections to Significance



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Operational Controls for Steam System

What sort of things would an auditor look for?

- Boiler operations criteria, start up, shut down, sequence, standby
- Boiler operator competence / training
- Maintenance procedures/records:
 - Steam trap survey, repair / replacement
 - Insulation repair / replacement
 - Boiler tube cleaning, water-side, fire-side
 - Steam leak survey / repair
 - Combustion tune-up records
- Monitoring & measurement:
 - Regular combustion, flue gas analysis
 - Make-up water meter readings
 - Meter readings of fuel input
 - Water quality testing (BW, CR, FW, MU)
 - De-aerator temperature / pressure records
 - Calibration records for steam system energy consumption meters

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Continual Improvement

- Start with a few significant uses – keep it manageable!
- Add to the identified significant energy uses over time, improving the efficiency and control of more equipment, systems, and processes.
- Addressing the connections associated with significant energy uses will quickly consume resources!

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Significant People

- Who operates the SEUs?
- Who maintains the SEUs?
- Who engineers the SEUs?
- Who manages the SEUs?



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Types of People

- Immediate and direct impact
 - SEU Operators
 - Maintenance and service personnel
- Influencers
 - Managers, supervisors, leaders
- Production people
- People who see things differently
 - Cleaners
 - Security
 - Safety Officers



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Estimate Future Energy Use

To estimate future energy consumption by use, consider:

- How will product mix change in the next 3-5 years?
- What is production level expected to be in 3-5 years?
- What operating equipment will be utilized (or idled) due to new product development, production mix or production volume changes?
- Will the same number of hours per year and shifts be operating?
- What are economic and industry forecasts indicating with respect to energy budgets or supply?
- Are supplier or material changes expected?

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Expert's Role in Significant Energy Uses

- Help organization determine who/what can significantly affect energy use and consumption
 - Facilities, equipment, systems, processes and personnel (employees or contractors)
- Help organization organize energy use data
- Help organization identify analysis method for determining significance

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Expert's Role in Significant Energy Uses

- Help organization determine the significant energy uses
 - Large energy consumer and/or large potential for energy performance improvement
 - Keep identified significant energy uses to a minimum
- Help organization determine the performance of components related to significant energy uses
- Help organization estimate future energy use

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Typical Barriers

- Not focusing on large energy users and systems
- Not including a cross-functional team when determining significance
- Identifying too many significant systems
- Inadequate submetering
- Inadequate data analysis
- Lack of connection with organization's strategic focus for future energy use estimation
- Focus on data or system inadequacies



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Value to the Organization Significant Energy Uses

- Identifies most significant energy uses
- Identifies most costly uses or uses with greatest improvement potential
- Highlights variables that affect significant energy uses
- Serves as a basis for comparison
- Estimation of future data
- Identifies potential future supply and demand issues
- Highlights opportunities for different purchasing practices

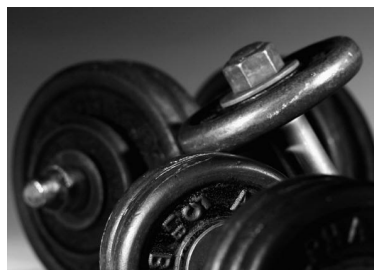


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Exercise

Review the Case Study for KRM Mining Co.
Using the Simple Energy Profiler tool,

- Enter utility data
- Enter the energy equipment and systems
- ❖ Look at the energy balance
- ❖ Determine the top energy consuming equipment & systems



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Deliverables

- Identify significant energy uses
- Energy Review – Estimate future energy use and consumption



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Exercise 07B – Significant Energy Uses

- Enter the information for your company' s motors into the Motor List worksheet in the Energy Balance spreadsheet tool.
- Enter the information for your company' s heat users into the Heat Users worksheet in the Energy Balance spreadsheet tool.
- Make estimates where there are gaps in information
- Answer the following questions:
 - Does the equipment entered account for 100% of energy consumption?
 - What are the largest motors and heat users?

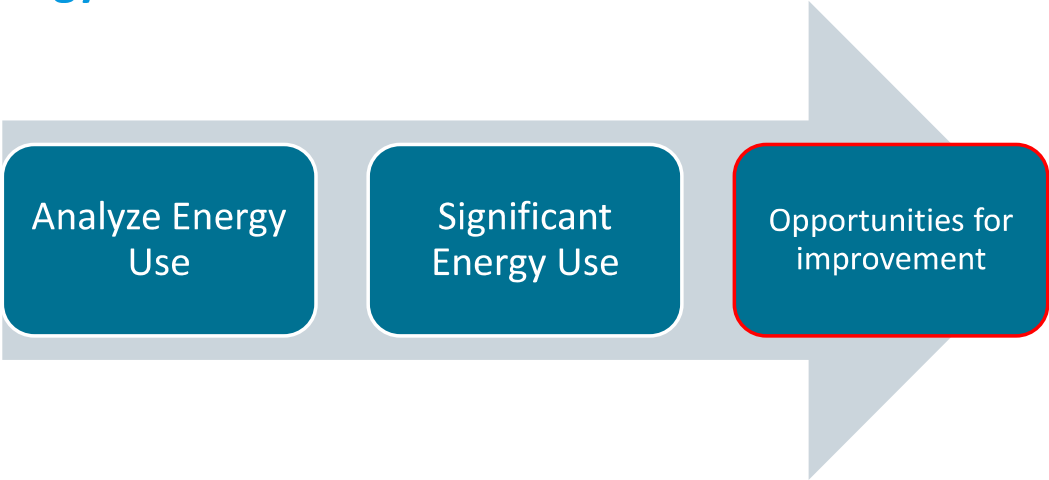
73

See you in 45 min 😊

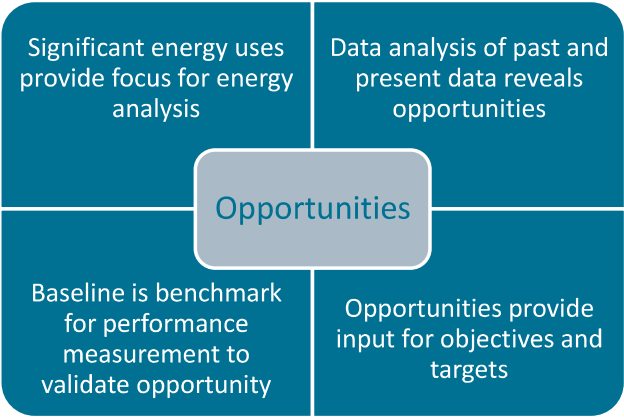


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Energy Review



Connections

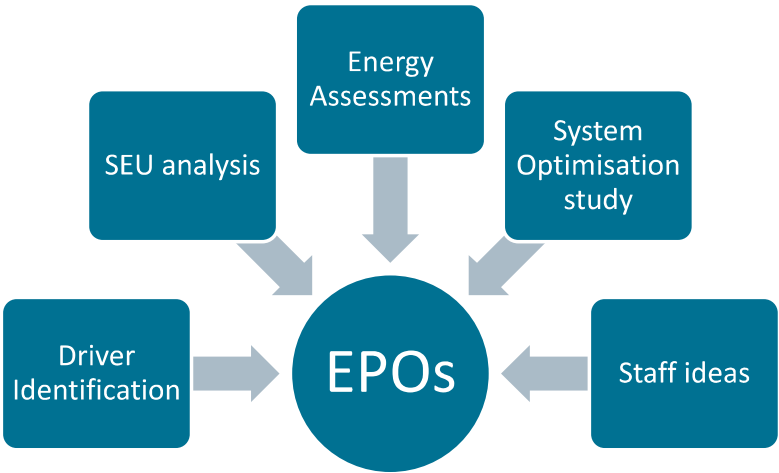


Prioritized List of Opportunities

- Identify and prioritize energy performance improvement opportunities, including where applicable,
 - Potential energy sources
 - Renewable energy sources
 - Alternative energy sources



Sources for Identifying Improvement Opportunities



Note: EPO = Energy Performance Opportunity

Energy Assessments

Information on:

- Equipment
- Systems
- Processes
- Facilities

About:

- Purchasing
- Use
- Reliability
- Storage
- Disposal

Outcome:

- Evaluate energy performance
- Help identify opportunities
- May determine significant uses

Energy assessments are not a requirement, but they can be utilized to identify performance improvement opportunities.

Examine potential for renewables and alternative energy sources

- Which renewable sources are available?
 - Solar (thermal or photovoltaic)
 - Wind power
 - Biomass
- Which renewable technologies are economical with these resources?
- Which alternative energy sources are available?
 - Waste heat recovery
 - Fuel switching
- Which might be economical?
 - Cogeneration (Combined Heat and Power (CHP))

System Optimisation

- Examine the whole system and not individual components
- Establish user requirements and specification
- Examine opportunities with use
- Examine opportunities with distribution
- Examine opportunities with generation last.

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Typical system approach process

- What does the user need?
 - Consider variations, e.g. seasonal, occupancy, production schedules, alternative services, etc.
- Optimise use of the service
 - How is it used, operations, controls, etc.
- Optimise distribution of the service
 - Leaks, pressure drops, insulation, etc.
- **FINALLY** optimise generation of the service
 - Boilers, chillers, air compressors, pumps, etc.

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Pump system example

- Minimise user requirement
- Shut bypasses
- Determine actual flow and pressure requirement
- Reselect motor and pump
- Replace 150m3/h with 25m3/h
- Save 75% or 176MWh p.a.



EPO Database

- Develop a list of all potential ideas
- Select items for implementation
- Plan and manage their implementation

ID	Description of Opportunity	Service	Investment Class	Capital Cost	Potential payback (years)	Estimated Savings				Person Responsible	Target Completion Date	Status	Notes, Barriers, Risks	Method of estimating savings	Actual savings achieved				Actual Completion Date
						kWh elec	kWh fuel	CO2	Financial						kWh elec	kWh fuel	CO2	Financial	
1	Fit VSD to boiler fan	Steam	Low	5000	1.43	3500				JB	01/04/2011	Approved	need service company to commission	Power has a cubic relationship with speed. Estimate average speed reduction and runs hours					01/04/2011
2	Replace lights in warehouse	Lighting	Med	3000	2.00	1500				KL	01/05/2011	Idea	waiting approval	Estiamte lighting load before and after and multiply by estiamted running hours per year					01/05/2011
3	Train operators in refrigeration efficiency	Mgmt	Low	1000	0.10	####				JB	01/12/2011	In progress		Audit operation in advance and estimate savings from improvements in operation control					01/12/2011
4	Reduce chiller condensing pressure	Ref.rig	No	0	-	4500				JB	01/02/2011	Idea	are there any risks	3% saving per degree C reduction					01/02/2011
5	Train cleaners in energy vigilance	Mgmt	Low	300	0.30	1000				JB	01/03/2011	Idea	prepare material	Assume 3% saving in relevant areas of the plant					01/03/2011

Prioritization of Opportunities

- Compile a list of opportunities from energy assessments, employee suggestions, etc.
- Determine and document prioritization criteria
- Apply the prioritization criteria uniformly to develop a prioritized list of opportunities

Example Criteria Rating

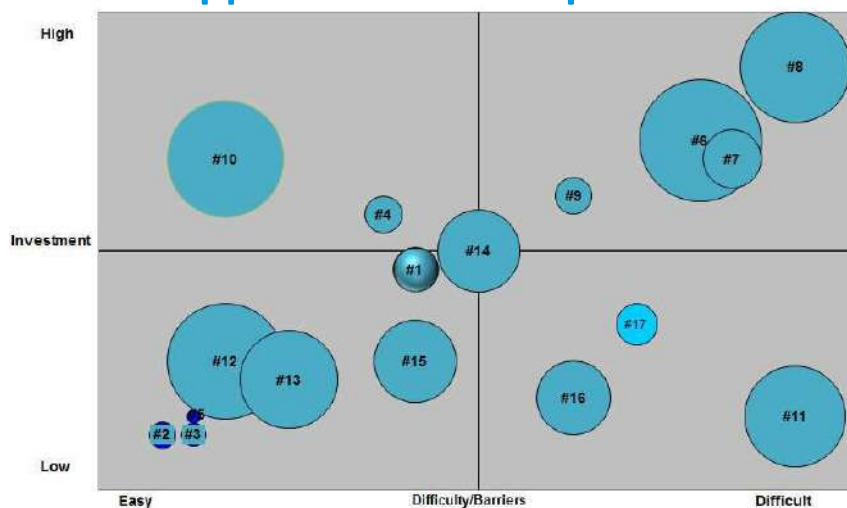
Criteria	Rating Description			
	1	2	3	4
#1 - Anticipated annual energy savings	Less than \$10,000/year	\$10,000-\$25,000/year	\$25,000-\$100,000/year	Greater than \$100,000/year
#2 - Expected time required for implementation	Greater than 12 months	6-12 months	Less than 6 months	Immediately
#3 - Simple Payback	Greater than 36 months	13-36 months	6-12 months	Less than 6 months
#4 - Estimated Cost	20% ≤ Cost Capital budget	10% ≤ Cost < 20% Capital budget	5% ≤ Cost < 10% Capital budget	Cost < 5% Capital budget
#5 - Environmental, Health, or Safety Impact	Increased negative impact on environmental, health, and/or safety conditions	Minimal negative impact on environmental, health, and/or safety conditions	No change to environmental, health, and/or safety conditions	Improved environmental, health, and/or safety conditions

Example Prioritization

Opportunity Description	Opportunity Rating					Total Rating
	Criteria #1	Criteria #2	Criteria #3	Criteria #4	Criteria #5	
Insulate steam pipes	2	3	4	4	4	384
Replace fluorescent T-12 lighting with T-8 lighting	2	2	2	3	3	72

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Which opportunities to implement?



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Exercise 7C Energy Opportunities

Review the list of energy performance opportunities for drying - KRM Mining Co. case study

Using the Opportunity Prioritization Tool,

- Determine what criteria you will use to prioritize opportunities
- Evaluate opportunities and rank them



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Expert's Role in Identifying Opportunities

- Help organization determine methods for identifying opportunities
 - Energy review and driver identification
 - SEU analysis
 - Energy assessments
 - System optimization study
 - Employee ideas
- Help organization prioritize opportunities
 - Determine method
 - Establish criteria
 - Rate and prioritize

90

Typical Barriers

- Lack of opportunity identification
- Neglecting employee input
- Focus on one method for opportunity identification
- Failure to establish prioritization criteria
- Failure to document prioritization criteria and decisions to ensure consistency
- Failure to prioritize



91

Value to the Organization

- Comprehensive list of opportunities
- List of prioritized opportunities
- Adequately focuses organizational resources



92

Energy Review Methodology

Whatever method and selection criteria* you use –
DOCUMENT IT!

*You determine the criteria for
“substantial energy
consumption” and/or
“considerable potential for
improvement.”



93

Maintenance of the Energy Review

Document criteria and method used to develop energy review

Ensure it is completed in a consistent fashion

Update energy review

- How frequently will the energy review be updated?
- What constitutes a major change?
- Who will be responsible for updating the energy review?
- How will the person responsible for updating the energy review know that a major change has occurred?
- What process ensures the energy review is updated on a defined interval and based on a major change?



94

Expert's Role in Energy Review

- Assist the facility in documenting the criteria and method used to develop the energy review
 - It is suggested that the data collection and analysis process be documented as it is completed to ensure it is easily repeatable
- Aid the facility in developing an update process
 - How frequently will the energy review be updated?
 - What constitutes a major change?
 - Who will be responsible for updating the energy review?
 - How will the person responsible for updating the energy review know that a major change has occurred?
 - What process ensures the energy review is updated on a defined interval and based on a major change?

95

Typical Barriers

- Failure to start with high level data and work down as time allows
- Obtaining too much specific information about every piece of equipment
- Failure to collect high level data on each energy source (propane, #2 fuel oil, etc), no matter how small
- Failure to define and document the data collection and analysis process as you go along to ensure it is easily repeatable
- Unable to use the energy review data in making decisions

96

Deliverables

- Energy review
- Criteria and methods used to develop energy review
- Defined energy review update process



97

See you in 15 minutes!

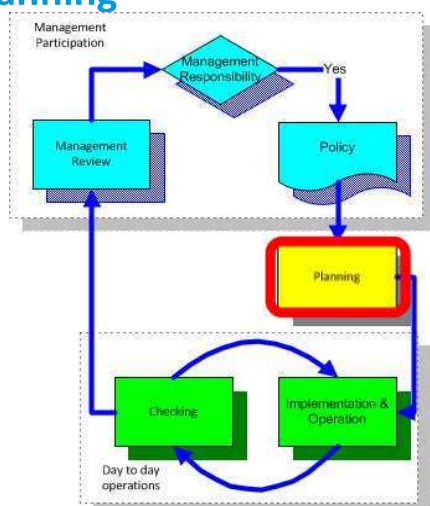


98

Energy Performance & Calculating Energy Savings

99

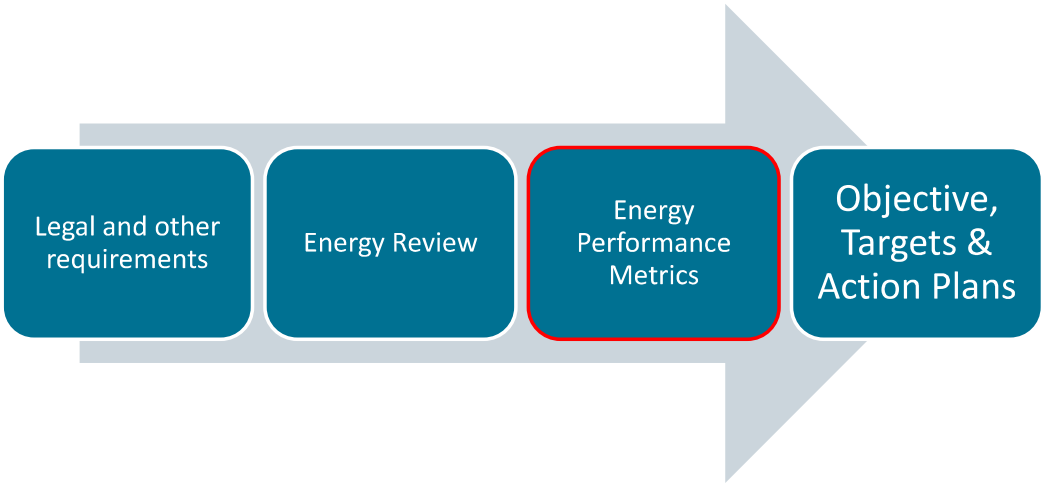
Planning



- How much energy am I using?
- Where am I using it?
- Which are significant users?
- What is driving it?
- Who is influencing its use?
- Are there opportunities for improvement?
- What is my future energy picture?
- Renewable energy options
- Are there legal or other requirements?
- **Develop baseline & indicators**
- Set objectives and targets
- Action Plans

100

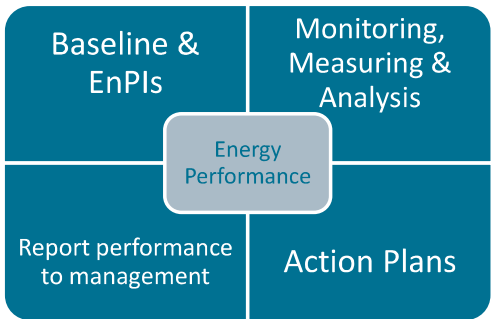
Planning



101

We need to be able to tell if our performance is improving

- This sounds relatively easy
- It is often not easy
- This topic affects many parts of the EnMS
 - Baseline
 - EnPIs
 - Monitoring and measuring (checking)
 - Verification of savings (action plans)
 - Identification of waste



102

What is M&V?

M&V= Measurement and Verification

Is the process of determining energy performance following a defined protocol

Multiple protocols in use

What do you use?

M&V Protocols & Standards

- ❖ ISO50015
- ❖ EVO: IPMVP (2007)
- ❖ U.S. DOE: Superior Energy Performance M&V Protocol
- ❖ ASHRAE: Guideline 14
- ❖ SATS 50010



103

M&V Protocols

- Guide to good practice, NOT a design manual
- May need M&V expert
- NOT a “Cookbook” or set of prescriptive procedures
- Improved energy performance results from a reduction in either energy consumption or use, or both
- We cannot *measure* what we do not have
- We do not “measure” this reduction
- BUT
- We can measure energy consumption, and
- Following a strictly defined PROTOCOL, we can **analyze** measured usage to arrive at improved energy performance or energy **savings**



104

Primary M&V Issue

Can be measured

- Temperature
- Flow
- Velocity
- Current
- Voltage
- Electrical power
- Operating hours

Cannot be measured

- Improved Energy Performance or
- Energy savings



No energy savings meter!

105

Calculating Savings

$$E_S = B_{peu} - R_{peu} \pm A$$

Where,

E_S = energy savings

B_{peu} = Baseline period energy use

R_{peu} = reporting period energy use

A = adjustments

106

Adjustments

- An example of why we need Adjustments:

An energy retrofit was performed but plant production is lower this year than last. How much of the raw “savings” were due to the retrofit and not the change in production?

- To identify the impact of the retrofit, we must adjust for unrelated changes.
- We adjust (“normalize”) base year and post retrofit energy use data to a common set of conditions.



107

M&V: Three Basic Options

1. Retrofit Isolation (2 flavors): Separate change
2. Whole Building: utility data
3. Calibrated Simulation: computer model

Total of Four Options



108

Retrofit Isolation: Options 1a & 1b

- Savings are determined by measuring energy use of the retrofitted system(s). Must measure all energy flows to the system(s).
- Usually uses specially added meters.
- Measures the performance of the retrofit ONLY.



Example: Lighting retrofit

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Retrofit Isolation (Option 1a) Example 1

- Baseyear measured load, July 1999 333 kW
- Post-retrofit measured load, July 2001 233 kW
Change in load 1 100 kW
- Stipulation: 300 assumed operating hours per month
Change in Raw energy use
100 kW x 300 hours = 30,000 kWh
- Adjust for lost tenant = -10,000 kWh
Savings = 20,000 kWh
- Option 1a ⇒ Partial measurement + Stipulation

110

Retrofit Isolation (Option 1b) Example 2

- Baseyear measured, July 1999 100,000 kWh
- Post-retrofit measured, July 2001 70,000 kWh
- Raw Difference 30,000 kWh

- Adjust for change in occupancy -10,000 kWh
- Savings 20,000 kWh

- Option 1b ⇒ Full measurement - Lighting Circuit ONLY.
No stipulation required!

111

Whole Facility: Option 2

- Savings are determined by measuring energy use at the whole facility level.
- Usually uses utility meters.
- Measures total facility performance, not just the retrofits.
- Generally applied where many retrofits are involved. Applied when cheaper than simulation (option 3).



Example: Building renovation

112

Whole Facility - Example 3

- | | |
|---------------------------------------|----------------------|
| • Baseyear electric bill, July 1999 | 800,000 kWh |
| • Post-retrofit bill, July 2001 | <u>600,000 kWh</u> |
| Raw Difference | 200,000 kWh |
| • Adjust for metering period, weather | + <u>100,000 kWh</u> |
| Savings = | 300,000 kWh |
| • Compare and adjust utility data | |

113

Calibrated Simulation: Option 3

- Savings are determined by simulating energy use before and after retrofit.
- Simulation model must be ‘calibrated’ with actual energy use.
- Used where there is no baseyear data available.
- Requires simulation experience.

Example: New Building Retrofit



114

Calibrated Simulation, Example 4

- Create computer model of facility
- Comparison of model with 2001 utility bills reveals simulation is adequately 'calibrated'
- Simulated utility use without retrofits
(2001 weather data) 960,000 kWh
- Simulated utility use with retrofits
(2001 weather data) 900,000 kWh
Difference is savings 60,000 kWh
- Comparison with same weather data (Independent variable)

115

M&V Plan Contents - 1

- Purpose of each EPO: what is expected
- Measurement boundaries: fenceline
- Interactive effects
- Baseyear energy
- Selection of independent variables (occupancy, weather, production); baseyear values
- Static conditions during baseyear: state factors affecting energy (audit)



116

M&V Plan Contents - 2

- Define test period: time
- Standard conditions for adjustments: pre, post or normalize
- Measurement option (A,B,C,D)
- Metering points, specs, & procedures: what, where, maintenance
- Quality control procedures
- Expected costs and accuracy
- Report formats and frequency



117

M&V Cost vs. Uncertainty

There is **no absolutely** correct savings number.

Every savings number is **wrong**, but we do not know the correct value.



118

How much M&V is enough?

Scenario	X	Y
Savings/Yr	\$100,000	\$100,000
Uncertainty	$\pm \$25,000$	$\pm \$5,000$
M&V Cost/yr	\$6,000	How much would you pay? Why?

119

How much M&V is enough? – 2

Total cost to determine savings should normally be less than
__% of the savings?
10%

Typically 1-5% spent to measure but no more than 10%

For \$100K savings, spend no more than?
10% or \$10K for measurement.
For our example, an extra \$4,000

120

How much M&V is enough? – 3

A Balancing Act between:

☐ **Lower uncertainty** (higher M&V cost) may give operating staff better feedback and tighter control
= more savings

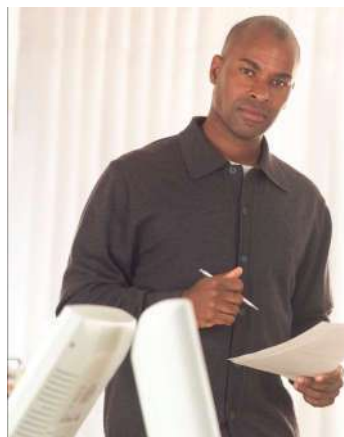
☐ **Higher uncertainty** (lower M&V cost) leaves more money for retrofits = more savings



121

Experts Role in Calculating Energy Savings

- Know which M&V options are appropriate for energy savings calculation situation.
- Know how much M&V is enough.
- Develop relationships with M&V technical experts.
- Provide guidance to set up performance criteria to determine savings



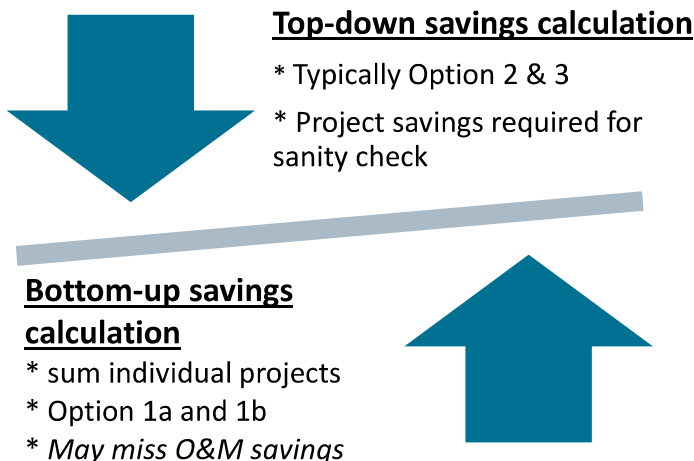
122

So, how do you calculate the energy performance improvement for your EnMS?

- Energy performance improvements are due to all of the energy savings occurring within the boundaries of the EnMS
- Some of these savings are due to capital projects
- Some of the savings are due to changes in operations and maintenance
- The total savings or energy performance improvement can be totaled from all of the projects and changes, or
- The total savings can be calculated from changes in utility or revenue meters readings

123

Calculate Total Energy Savings for EnMS



124

Exercise 08: Calculate Energy Savings

- Plant 35 of ABC Company is reporting their annual energy savings to their corporate offices.
- Calculate their annual energy savings using the data that is provided.
- Complete the annual energy savings table that is provided in the tool.



125

**Day 2 End
Thank You**

126

Energy Management System (EnMS) Expert Training

UNIDO International Energy Efficiency and EnMS Training

Module 1 Day 3

Delivered by: Richard Morrison, Stefan Walta

1

Welcome and Introductions

- Richard Morrison, Stefan Walta
- Name
- Organisation
- Energy Management Experience
- What do you expect to learn over this program?



2

Housekeeping

- Emergency Exits
- Toilets
- Mobile Phones
- Breaks
- Lunch
- Please restrict email to break times
- Interact and ask questions



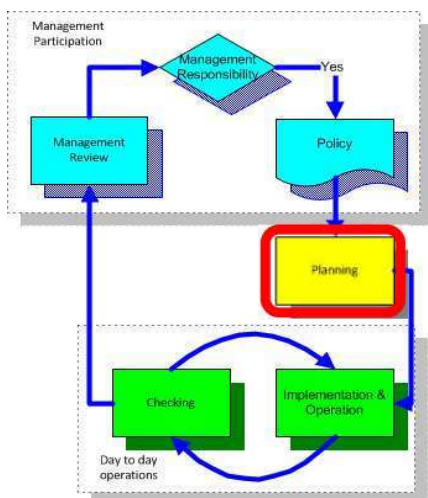
Today

Start Time	End Time	TOPIC	DURATION (min)	EXERCISE (min)
08:30	09:30	EnPIs AND BASELINE	60	
09:30	10:00	EnPI TOOL	15	
		* Illustrate EnPI Tool use with Data Set		15
10:00	10:15	BREAK	15	
10:15	11:30	* Exercise 09: Plant-wide EnPI Calculation		75
11:30	12:00	INTRODUCTION TO DOCUMENTS	30	
12:00	13:30	LUNCH	90	
13:30	15:00	OBJECTIVES, TARGETS & ACTION PLANS	60	
		* Exercise 10: Determining Objectives and Targets		30
15:00	15:15	BREAK	15	
15:15	15:30	MANAGEMENT REVIEW OF ENERGY PLANNING	15	
15:30	16:30	CHANGE MANAGEMENT	30	
		* Group Discussion: changing organizational culture		30
16:30	16:45	COMMUNICATIONS & NEXT STEPS	30	
16:45	17:00	Closing Remarks	15	

Energy Performance Indicators and Baselines

5

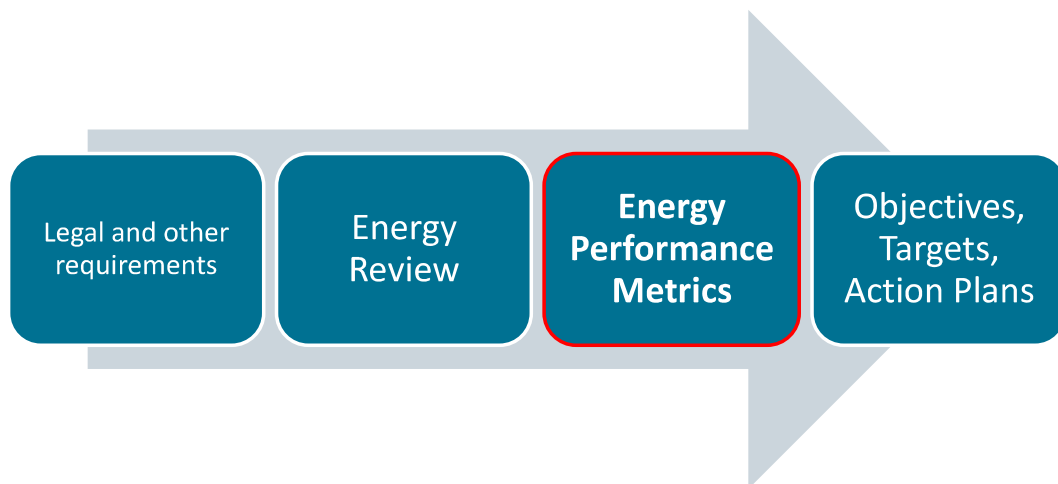
Planning



- How much energy am I using?
- Where am I using it?
- Which are significant users?
- What is driving it?
- Who is influencing its use?
- Do I need to have an energy assessment (=audit)?
If yes, focus it
- System Optimization
- Renewable energy options
- Are there legal or other requirements?
- **Develop baselines & EnPIs**
- Set objectives and targets
- Action Plan

6

Energy Planning



7

Purpose of energy metrics

- Objective support for decision making
 - too often subjective reasons are used!
- We need to know how much energy we are using
- We need to know if **performance** is improving
- We need to know if we are meeting targets
- We need to be able to **verify savings** of improvements

$$E_S = B_{peu} - R_{peu} \pm A$$

8

Example Performance Indicators

- Facility-wide EnPIs
- Process-unit level
 - Product specific
 - Process specific
- Energy System level
 - Compressed Air – kW / m³/sec
 - Steam systems – kWh / kg/hr
 - Furnace – kWh / unit

9

Energy Metrics – levels of complexity

- Simple:
 - Simple: consumption last month v same month last year
 - Simple: compare actual consumption with budget
 - Simple: annualised trend of cost and consumption
- More complex (but beware!)
 - Energy use per unit output
 - Cooling energy per cooling degree day
 - Specific energy consumption (SEC)
- Regression analysis is usually best
- Same principles apply to EnPIs and verification of savings

10

Simple ratios – beware!

- Energy use per unit of output (Energy Intensity)
 - e.g. kWh/T of product
 - Useful in energy intensive industries for benchmarking internally and externally
 - Beware in others, especially in cases with large baseloads
 - Almost of no value in judging energy performance
 - Usually tracks output better than energy
- Energy Efficiency (energy in compared with energy out)
 - E.g. boiler efficiency is a useful indicator but beware:
 - Decreasing boiler load through pipe insulation, leak repair or demand management will almost always result in reduced efficiency due to lower loads
 - Overall system efficiency will improve but not the boiler efficiency

11

Annualised trend

- Moving total of previous 12 months (or 52 weeks, etc)
- Removes seasonal effects
- Gives a real view of comparison v budget
- Effects of a change stay for next 12 periods
- Absolute numbers
 - No allowance for changing drivers or activity levels
- Very useful for forecasting, you can quickly judge what next 12 months use will be
 - You need to correct for known changes in output or other

12

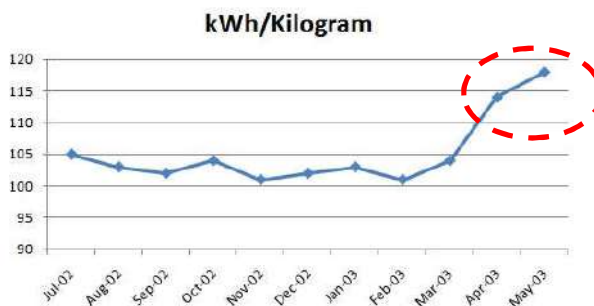
Other indicators - be careful!

- Specific Energy Consumption (SEC)
 - For example air compressor SEC will usually increase if leaks are repaired or demand reduced.
 - This does not mean you shouldn't reduce demand
 - It means that care is needed in the use of this indicator
- Coefficient of Performance (COP)
 - Used as a measure of refrigeration plant performance
 - = cooling load (kW) / electrical power to compressor (kW)
 - COSP = cooling load (kW) / power to compressors plus auxiliaries loads such as fans and pumps
 - Often reduces as load reduces (centrifugal compressors can be an exception)

13

kWh/Kilogram

What Caused Increase in Energy Intensity (kWh/Kilogram)?



- Did the plant start using energy more inefficiently?
- Or, did other variables impact energy consumption?

14

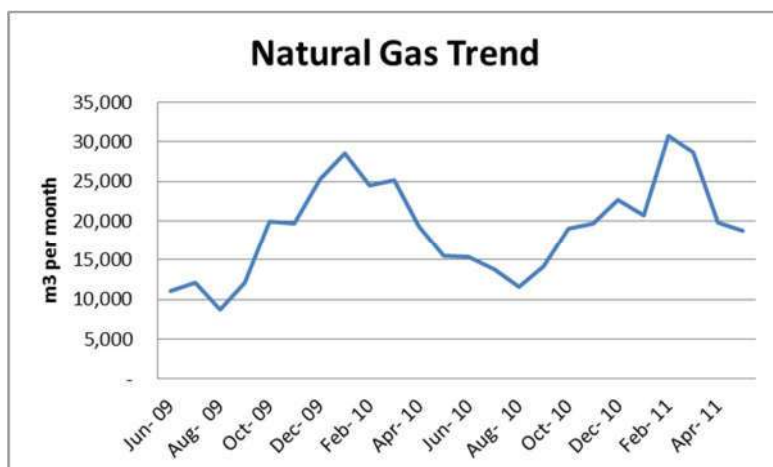
Problem: energy consumption varies due to,

- Weather
- Daylight availability
- Production throughputs
- Mileages
- Occupancy
- ...etc
- “driving factors”
- Terminology: drivers, independent variables, energy factors
 - All mean the same, decide which you will use



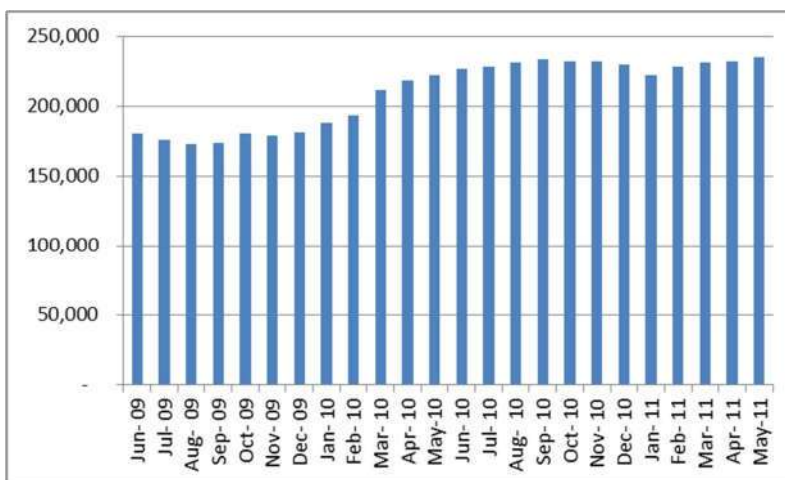
15

What does this tell us?



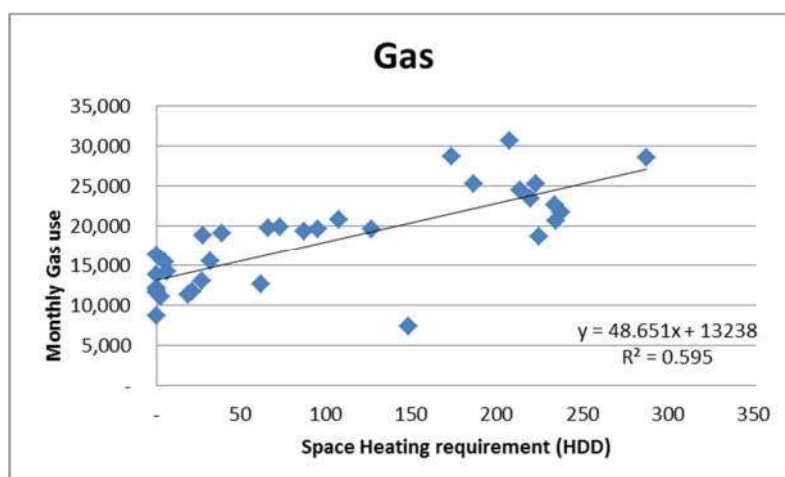
16

Same gas data in annualised view



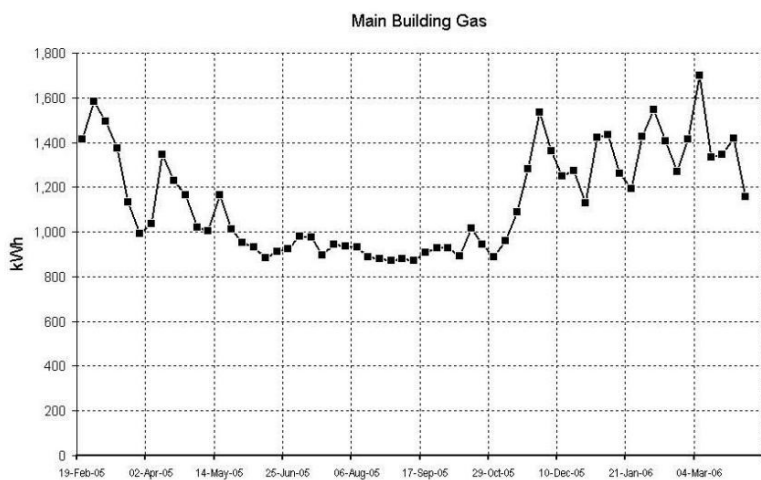
17

Previous gas data vs heating degree days (HDD)



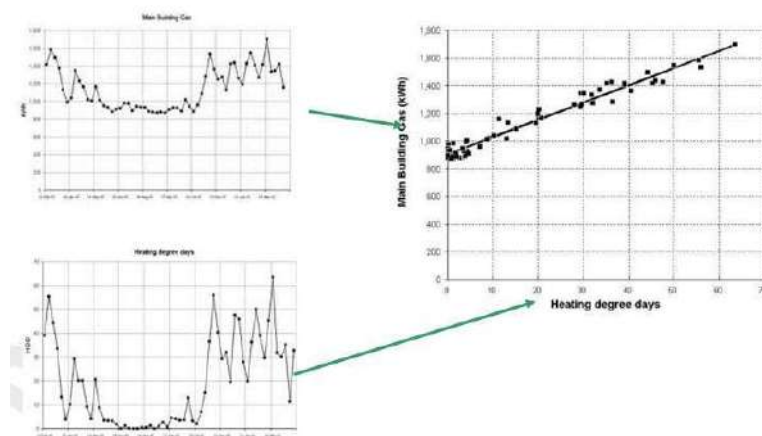
18

Another Example: Gas consumption



19

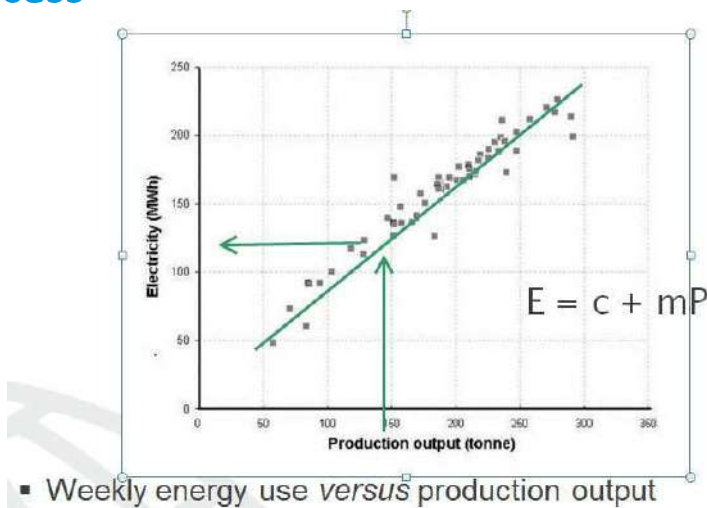
Example: Determine drivers



Gas consumption plotted against degree days

20

Simple process



21

Straight line formula

- $Y = mX + C$
- Energy (E) = Factor (F) * Driver (D) + Constant (c)
- $E = FD + c$
- In the previous case:
 - $\text{Gas} = 48.651 * \text{HDD} + 13238$
- This formula can be used to predict expected consumption for any given driver
- **We can compare predicted vs. actual usage to indicate performance!**

22

In general


- Expected energy consumption can be any function of relevant driving factors, D

$$E = f(D1, D2, Dn)$$

- Use the simplest effective model
- A straight-line relationship is often good enough

Multiple factor case

Fixed	123,000 kWh per week	1 weeks	123,000 kWh
Bread	190 kWh per tonne	93 tonnes	17,670 kWh
Tarts	310 kWh per tonne	5 tonnes	1,550 kWh
Rolls	250 kWh per tonne	75 tonnes	18,750 kWh
Space heating	1,200 kWh per degree day	20 degree days	24,000 kWh
Total:			184,970 kWh



$$E = c + m_1D_1 + m_2D_2 +... + m_nD_n$$

Source: Vilnis Vesma

Other models

Multivariate linear regression:

$$Y = b + m_1X_1 + m_2X_2$$

Polynomial linear regression:

$$Y = b + m_1X_1 + m_2(X_2)^2$$

Nonlinear regression (energy use in cement industry):

$$E_i = \beta_0 + \beta_1 \ln(\text{capacity}) + \beta_2 \ln(\text{labor hours}) + \beta_3 \ln(\text{total cement production})$$

$$+ \beta_4 \ln(\text{number of kilns}) + \beta_5 (\% \text{ masonry}) + \beta_6 (\% \text{ 4 or other})$$

$$+ \beta_7 (\% \text{ wet}) + \varepsilon_i$$

Courtesy of Argonne National Laboratory and EPA, ANL/DIS -06-3

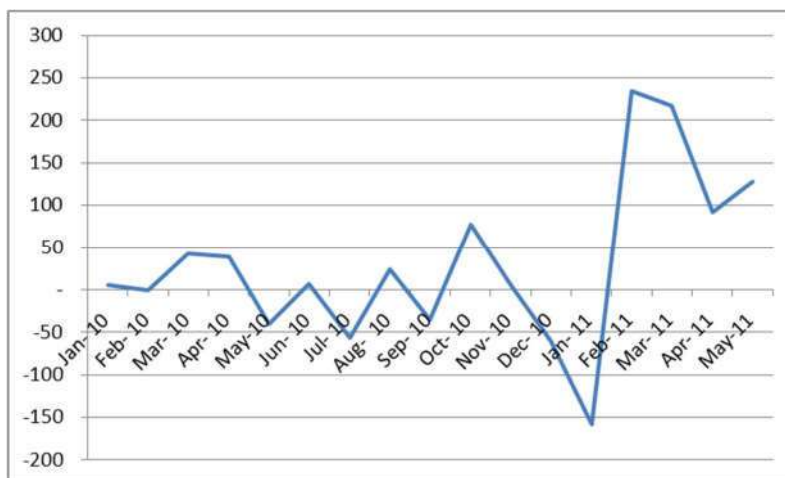
25

The main message

- Establish relationships between energy consumptions and appropriate energy (driving) factors
- Sometimes called “performance characteristics”
- Use these to **calculate *expected consumption*** based on production activity, prevailing weather etc.
- Thereby detect unexplained deviations

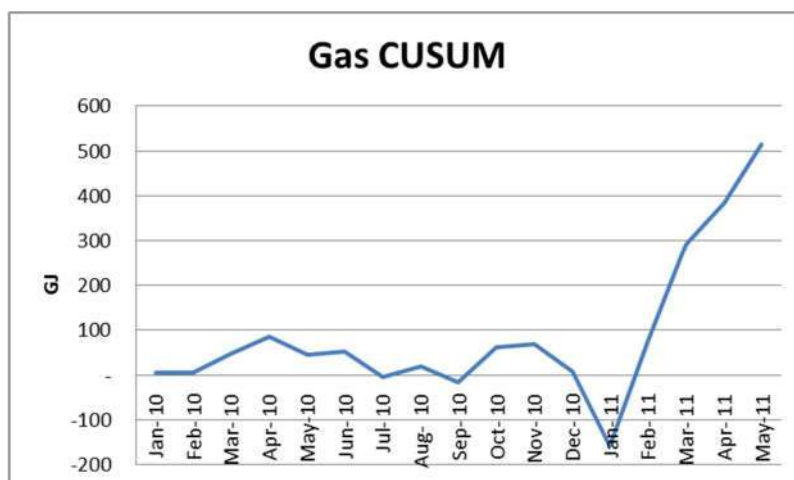
26

Difference between expected and actual



27

CUMulative SUM of difference (CUSUM)



28

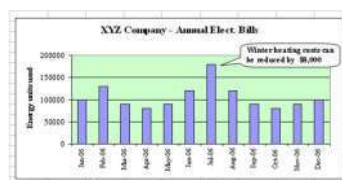
Performance checking with EnPI

- We use energy for known purposes (“outputs”)
- If we can measure useful output, we should be able to estimate *expected* energy consumption
- Thus we can gauge actual consumption...
 - Waste relative to target characteristic
 - Savings relative to historical baseline

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Energy Baseline

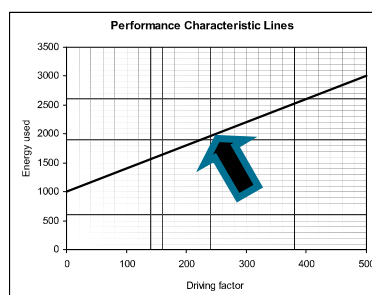
- Basis of comparison for evaluating energy performance
 - Facility-wide
 - Systems and equipment
 - Significant energy uses
- Uses pieces of initial energy review
 - Energy use data
 - Energy consumption data
- Facility-determined time period
 - Point in time
 - Period of time
- Measure energy performance improvement against the baseline



30

Targets and baselines

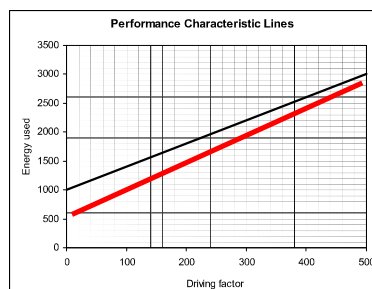
- “Target” characteristic
 - For management control
 - Base on best achievable performance
 - Keep continually adjusting



31

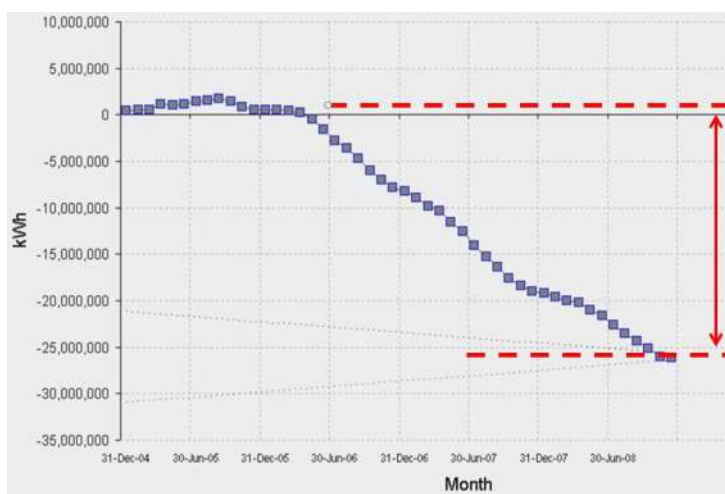
Targets and baselines

- Historical baseline characteristic
 - For assessing savings
 - Usually derived from ‘base year’ data
 - Leave unchanged



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Cumulative savings can be tracked



33

Historical baseline characteristic

- Answers the question *"how much would I have used in the absence of my energy-saving measures?"*
- Allows absolute kWh savings to be computed
- Gives clean, objective view
- Production, weather, etc. already accounted for

34

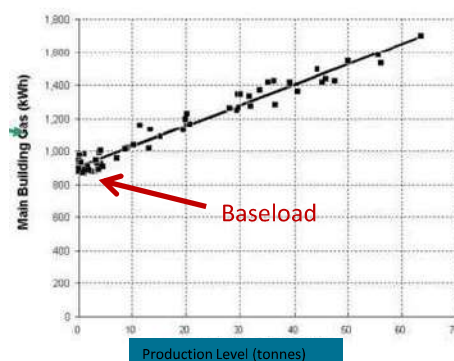
Baseline alternatives

- Baseline will be used for future comparison of improvements
- Ideally based on regression analysis as shown
- Can be absolute consumption, e.g. 1 GWh per annum
- SEC: kWh per unit of output

35

Baseload

- The energy you use when there is no productive activity
- Very often a major opportunity for improvement
- Measure and analyse baseload if it is significant



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Adjust Energy Baseline

- Major process changes
- Major operational changes
- Major energy system changes
- When EnPIs no longer reflect organizational use
- As determined by the organization (predetermined method)

37

Expert's Role in Baseline

- Aid the facility in determining relevant baseline(s)
- Help facility determine data needs for performance evaluation
- Help the facility organize and record the baseline(s)
- Help the facility determine data from the initial energy review relevant for the baseline

38

Value to the Organization

- Understand energy use for baseline period
- Have a comparative point for measuring improvement



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Documents & Records

Documents

- Identified Energy Performance Indicators (EnPIs)
- Method for determining and updating EnPIs
- Energy management baseline

Records

- Baseline (data pieces of initial energy review)
- Review and comparison of EnPIs to baseline

40

Tools

- EnPI Tool
- Checklist of Potential Factors Affecting Energy Consumption

41

Deliverables

- Develop Energy Performance Indicators (EnPIs)
- Document method for determining and updating EnPIs
- Determine Baseline (data pieces of initial energy review)
- Methodology for baseline development recorded



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Further information

- www.degreedays.net
- www.vesma.com
- www.evo-world.org
- Internet search results for:
 - CUSUM
 - IPMVP
 - Lean Energy Analysis

43

Illustration of EnPI analysis in Excel

44

See you in 15 minutes!



45

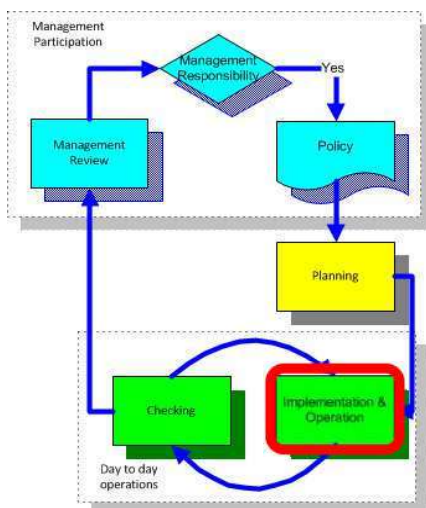
Exercise utilising sample data to develop
EnPI in Excel

46

Introduction to Documentation

47

Documentation



- Some specific documentation is required by an EnMS
- Organizations have both the flexibility and the responsibility to determine additional needed documentation
- Documentation can guide behaviour or activities, or provide evidence of what we have done.

48

DOCUMENTATION = INFORMATION

There are two basic types of documentation:

- **Documents** provide information about the present (say what you do)
- **Records** provide information about the past (prove you did what you said)



49

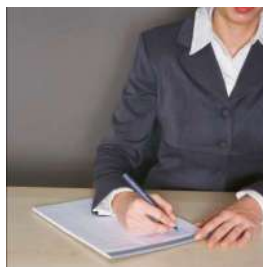
What's the difference?

Documents

- state current policies and commitments
- implement policies and commitments
- guide activities and operations, typically defining
 - ✓ what is to be done
 - ✓ who is to do it
 - ✓ when it will be done
 - ✓ how it will be done

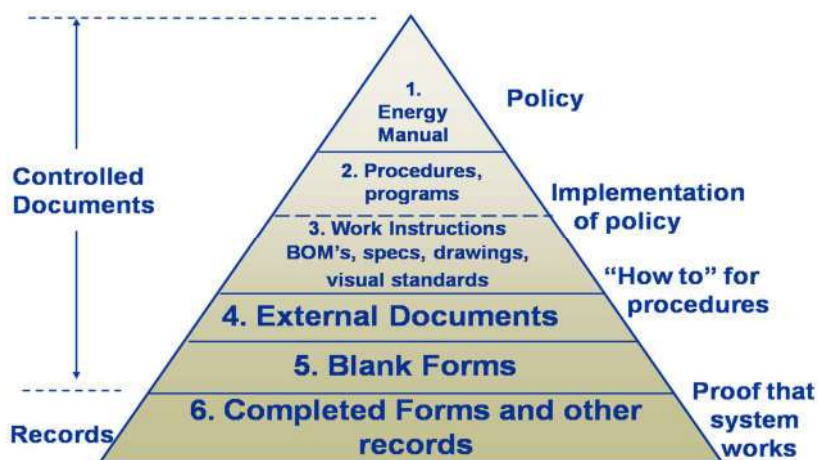
Records

- state results achieved
- provide evidence of activities performed



50

Typical Documentation Structure



51

Generic Examples of Documents

- Policies
- System procedures
- Operational procedures
- Work instructions
- Blank forms
- Manuals
- Plans and programs
- Drawings and schematics
- Standards and specifications
- Videos
- Photographs
- Sample boards

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Examples of EnMS Documents

- Scope and boundaries
- Description of core elements and their interaction
- Energy policy
- Energy objectives and targets
- Energy management action plans
- Methodology and criteria used to develop the energy review
- Methodology for determining and updating the EnPIs
- Other documents determined necessary

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Energy Manual

- Commits to the requirements of the EnMS and is approved by top management
- Typically, serves as a “roadmap” to the EnMS
 - Describes the components of the EnMS and how they interact (based on PDCA)
 - Provides direction to or references key EnMS procedures
- For smaller organizations, it is useful as a “one-stop shop” for documenting information about the EnMS

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Written Procedures vs. Additional Training



Additional training can be completed to reduce the number of necessary written procedures and other documents in your system.
But, records are **REQUIRED!**

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Typical Barriers

- Organizational culture
 - Document nothing
 - Document everything



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Documents—Value to the Organization

- Provide guidance for employees in new roles
- Consistency in tasks or activities performed
- Communicate expectations to contractors and suppliers
- May facilitate training and understanding



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Generic Examples of Records

- Completed forms
- Reports
- Data analyses
- Meeting minutes
- Training certificates



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Examples of EnMS Records

- Energy review, baseline, EnPIs
- Training records
- Decision regarding external communication
- Results of design activity
- Monitoring and measurement results
- Audit results
- Management review records

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Records—Value to the Organization

- Ensures clear evidence of activities and results
- Provides basis for data analysis
- Can serve as
“organizational memory”
for those who come later



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Expert's Role in Documentation

- Check for and understand existing documentation formats, controls and systems
- Develop a documentation plan
- Help establish criteria for determining needed EnMS documents
- Review required documents for conformance to EnMS requirements
- Ensure users are represented in document development processes



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Time to Make Friends!

- Meet the document coordinator for existing management systems
- Take a look at what already exists
- Work with them to incorporate the EnMS documents
- If all else fails ... harvest what they have and adapt it for your use



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Success Factors

Documents

- No unnecessary documents; no over-documentation
- Developed with input from users
- User-friendly formats and media
- Updated as needed

Records

- Records that:
 - Meet basic EnMs requirements
 - Prove what you are doing
 - Demonstrate achievement of improved energy performance
- Clearly defined responsibilities

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Deliverables

- Document describing how the organization will meet requirements of the energy management system (energy manual)

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See you in 45 min 😊

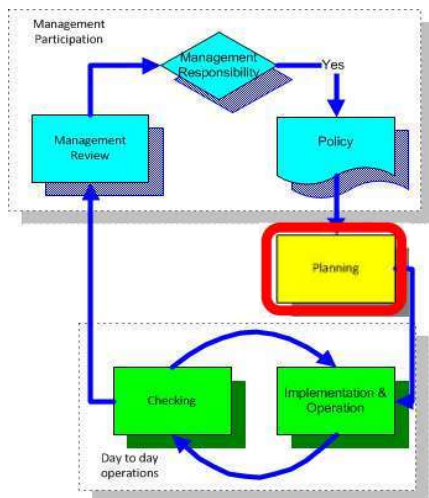


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Objectives, Targets & Action Plans

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Planning



- How much energy am I using?
- Where am I using it?
- Which are significant users?
- What is driving it?
- Who is influencing its use?
- Do I need to have an energy assessment (=audit)?
If yes, focus it
- System Optimization
- Renewable energy options
- Are there legal or other requirements?
- Develop baselines & EnPIs
- **Set objectives and targets**
- **Action Plan**

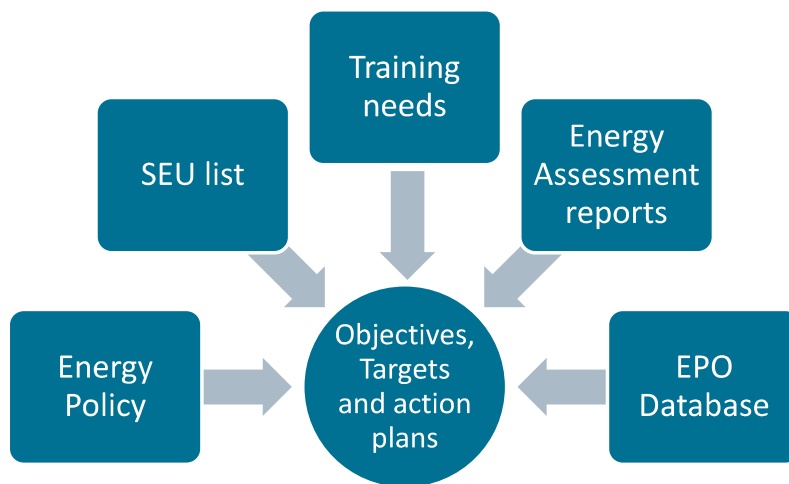
67

Purpose:

- Review Objectives and Targets
- Review Action Plans
- Incorporate EnMS Implementation and Operation considerations into Action Plans

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Objectives, Targets and action plan

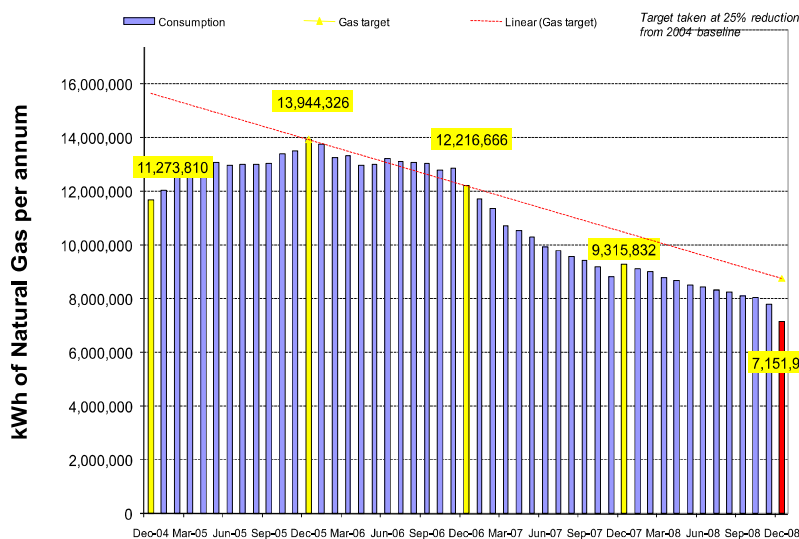


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Relationship

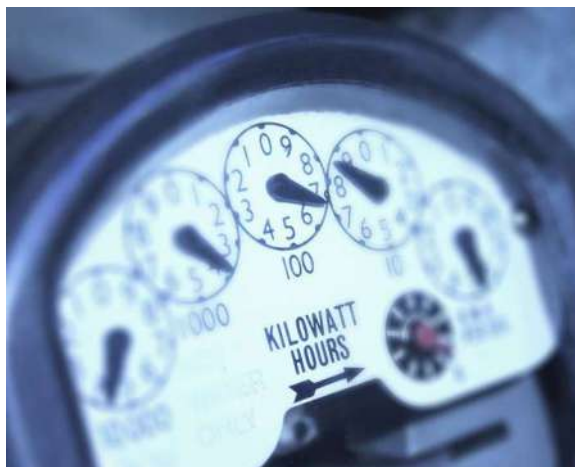


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Energy Objectives

- Improve performance
- Demonstrate policy
- Engage employees
- Engage stakeholders
- Focus resources



Examples

- Objective: Reduce facility electricity costs by 20% over the next two years.
- Objective: Reduce facility natural gas usage by 15% by 2025.
- Objective: Reduce facility-wide energy usage by 25% by 2030



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Targets

Specific

- What is the task to be done, use action words
- What are the details?

Measurable

- How will we know if the task is complete and how well?

Achievable

- Is it possible and fair?
- Is training or personal development required?

Relevant

- Which objective is it supporting?
- In what way is it improving our energy performance?

Timed

- When will it be completed or how often?
- Does it need sub steps and are these SMART?

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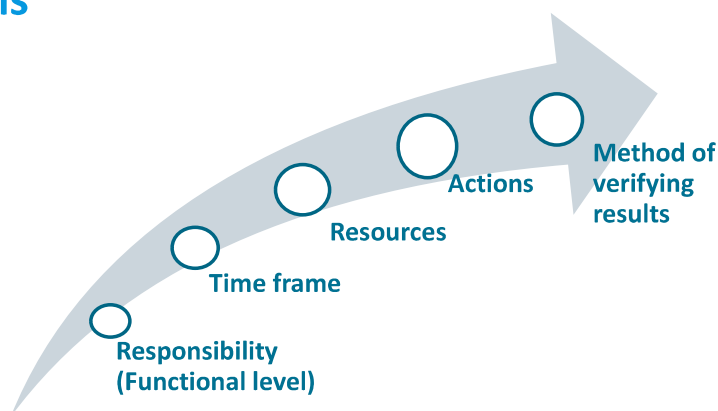
Examples

- Target: Reduce natural gas usage in boiler house by 25% in 2024.
- Increase condensate recover rate to 90% in 2025.
- Conduct 4 energy awareness training sessions in 2024.
- Train boiler house operator on new startup / shutdown procedures by end of 2nd quarter, 2024.



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Action Plans



Documented and
 Updated at
 defined intervals

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Plans required for objectives and targets

- Plan includes:
 - Responsibilities (who)
 - Timeframe (when)
 - Resources
 - Actions (what)
 - How improvement in performance and plan results will be verified**
- Documented
- Updated at defined intervals



Action Plan

- Objective:** Reduce facility natural gas usage by 15% in 2024.
- Target:** Reduce natural gas usage in boiler house by 25% in 2024.
- Project:** Install heat exchanger to preheat combustion air 800°F above ambient
- Actions and Responsibilities:**
 - ✓ Design – Mechanical department
 - ✓ Installation – Acme Contracting
 - ✓ Testing – Mechanical department and maintenance
 - ✓ Results verification – Mechanical department

Time Table



Benefits of Objectives and Targets

- Demonstrates policy commitment of energy as an organizational priority
- Links the policy and quantifiable performance improvement
- Provides framework for action on energy opportunities
- Allows the staff to share accountability and responsibility for energy performance

Focuses resources



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Hierarchy in ISO 50001



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Success Factors

- Stated objectives and targets should be SMART
 - S – specific
 - M – measureable
 - A – achievable
 - R – realistic
 - T – timely
- Ensure objectives and targets align with current business objectives and priorities
- Understand capital constraints and take this into consideration when developing objectives

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Role of the Expert

- Review the objectives and targets.
- Review all the inputs / connections and make sure they are addressed.
- Ensure targets meet objectives.
- Review action plans and check that they will meet energy objectives and targets.
- Ensure action plans have valid M&V procedure for measuring results and planned performance improvement.



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Exercise 07

- Review the Energy Objectives and Targets for your organization.
- Review your Energy Performance Opportunities Database.
- Will the targets meet your objectives?
- Will your EO meet your targets? Do you need to have an energy assessment?



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Deliverables

- Determine Energy Management Objectives
- Define Energy Management Targets
- Develop Action plan(s) for each Target



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See you in 15 minutes!



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Management Review of Energy Planning

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What Does the EnMS Require?

- Top Management review of Energy Management System
 - Planned intervals
 - Suitability
 - Adequacy
 - Effectiveness
- Maintain records

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What Does the EnMS Require?

Inputs to Review

- Previous action items
- Policy
- Energy performance (including EnPIs)
- Legal and other requirements compliance evaluation results (including changes in requirements)
- Energy objectives and targets status
- EnMS audit results
- Corrective and preventive action status
- Energy performance projection
- Recommendations for improvement

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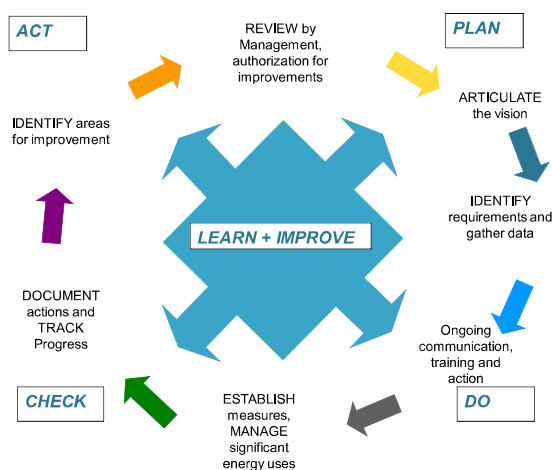
What Does the EnMS Require?

Outputs from Review (Decisions or Actions)

- Energy performance
- Energy policy
- EnPIs
- Objectives and targets
- Resource allocation
- Other energy management system components

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Management Reviews Drive Improvement



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Management's Role

- Determine **who** should be involved in the review process
- Identify **planning items or issues** to consider in the review
 - e.g., policy, significant energy uses, EnPIs, legal and other requirements, energy review
- Determine **when** to conduct the management review



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Successful Planning Review

- Management review of planning allows for:
 - Mid-course correction in planning function
 - Rapid decisions on energy planning requirements
 - Demonstrates involvement of top management
 - Increased visibility of energy management planning

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Documents & Records

Documents

- Not at this time

Records

- Management review records (including inputs and outputs)

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Deliverables

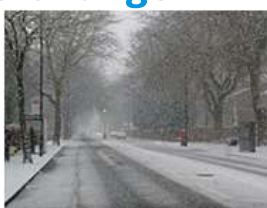
- None required at this time
- Recommend on-going communication with top management throughout the demonstration
- Consider partial management review covering planning efforts and results

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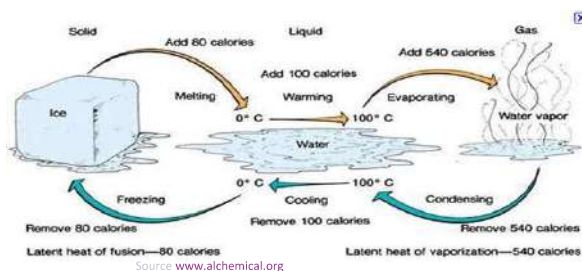
Change Management

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What is Change?



Source Wikipedia



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What is Culture?

Culture is any and all of the following:

- the way things are done around here
- What is OK and what is not ok
- Where we sit
- What time we come to work
- Documented and undocumented rules behavior etc

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Where do we need behaviour change?

- Top management need to change, support and make decisions
- Middle management are often a barrier to change
- Operational control requires changing work practices
- Energy reduction is one of the few costs in an organisation which does not have personal impact
- Why do we resist?
 - Personal status
 - Blame culture
 - Fear!

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Change Management Process

Eight step change model (*John P. Kotter* : Leading Change)

1. Create a sense of urgency
2. Build support from key influencers
3. Create a vision of what can be achieved
4. Communicate the vision
5. Remove obstacles
6. Create short term wins
7. Build on the improvements
8. Anchor the change in your culture

This process can be aligned with your EnMS development

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1. Create a sense of urgency

- External or internal context (PESTLE analysis)
- Cost Reduction
- Climate Change
- Carbon Emissions/Decarbonisation
- Competition
- Changes to the market
- Non-energy benefits
- Price rises
- **Needs top management support**



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2. Build support from key influencers

Support

- Management
- Employees
- About bringing people with you on change journey
- Momentum
- Communication
- Emphasise urgency

Key Personnel

- Influencers of change (Informal leaders)
- Senior Management
- Production
- Quality
- Engineering
- Employee Representatives

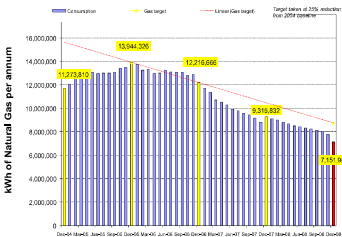
3. Create a vision of what can be achieved

What is possible

- Long Term
- Use Examples e.g. 50% reduction achieved elsewhere
- Previous success in UNIDO programs
- What are competitors doing?
- Goal Alignment

Do not accept

- They are different
- It's easy for them
- etc.



4. Communicate the vision

The 5 W' s

- Who should be told
- When to communicate
- What is the message
- Where will it be delivered
- Who is responsible

Non Verbal

The message

- Urgency
- Benefits
- What others have achieved
- Your plans
- What success looks like

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5. Remove obstacles (link to Risks and Opportunities)

What barriers?

- Weakness and threats from SWOT analysis
- Resistance to change
- Lack of commitment
- Lack of Knowledge
- Existing procedures and practices

What solutions?

- Communication
- Negotiation
- Urgency
- Benefits (including non-energy benefits)

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6. Create short term wins

Opportunities

- Easily implemented
- Highly visible
- Large impact
- Low cost (operational control)
- Use data where possible

What kind

- Compressed air leaks
- PIR on lighting
- Boiler house noise reduction
- Reduced heat in process area
- Convince the non-believers

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7. Build on the improvements

Action Plans

- Communication the successes
- Continual improvement
- Stakeholder involvement
- More technical projects
- Larger teams
- Relentless focus

Focus on the Vision

- Regular engagement
- Take on bigger improvements
- Engage with more personnel
- Continue communicating
- Not a project

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8. Anchor the change in your culture

Relentless Focus

- Re-evaluate the vision
- Communication
- Not a Project
- Need to make it the new culture
- Make the switch to sustainability permanent
- Integrate into business



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Change Management

“It is not the strongest of the species that survives, nor the most intelligent; it is the one that is the most adaptable to change”

Charles Darwin

Source: John P. Kotter Leading Change

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Change Management Exercise

How can you create the sense of urgency?

How can you increase support for energy performance improvement?

Consider all the barriers you will encounter

What is your vision for the EnMS in 3 years time?

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Communications & Next Steps

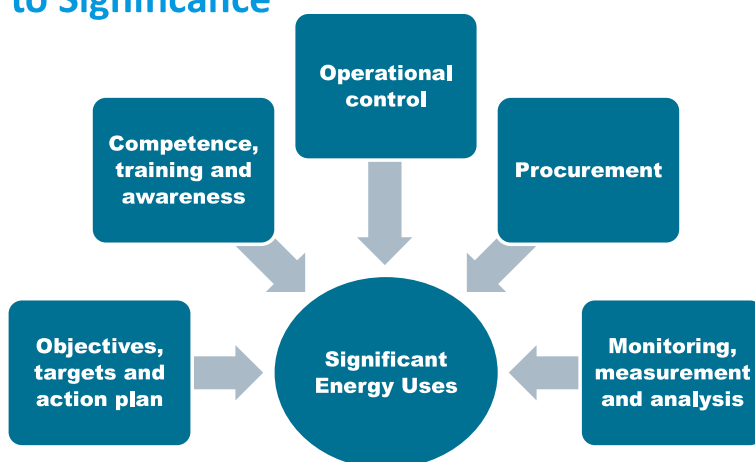
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TOPICS

- 2nd Expert Training
- Plant Teams
- Deliverables
- Communication
- 3rd Expert Training

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2nd Expert Training content: Connections to Significance



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2nd Expert Training content:

External national experts work with each plant to implement EnMS

Teams formed according to skill set and geography, as much as possible

Need to have management system expert on each team, if possible

Meet monthly to develop EnMS and complete homework assignments

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Demonstration Communications

- Face-to-Face Trainings
 - International experts, national consultants, plant personnel
- Monthly Consultant Team Calls
 - International experts, national consultants
- One-on-One Coaching
 - National consultants, plant personnel
 - Teams to decide how this will be done
 - Limited international experts, national consultants

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Monthly Webinars

- Location 1: typically last ____ day of Every Month*
 - Location 2: typically last ____ day of Every Month
- Dates to be agreed during training

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Monthly Webinars

- Each webinar is 1 to 1.5 hours in length
- Beginning will have 20-30 minutes additional training
- Remaining time is open forum for national experts to discuss issues, concerns and progress with international experts
- National experts meet as a group during webinars if appropriate
- Remote connection also provided
- Additional Training content will focus on deliverables list
- Topics will also be determined by the needs of the group
- Communication: International experts are source of last resort
- National experts are primary providers of implementation assistance

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Communication Tools

- BasecampTM
 - discussion forums
 - file sharing
- Microsoft Teams for webinars

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**Day 3 End
Thank You**

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DISCLAIMER

This document was developed within the framework of the project “Accelerating energy efficiency in large industries through energy management systems, system optimization and the promotion and adoption of energy efficiency in small and medium-sized enterprises (IEEP)”, funded by the European Union (EU), managed by the Ministry of Industry and Trade (MOIT), and implemented by the United Nations Industrial Development Organization (UNIDO). The content of this document is the sole responsibility of the Project and does not necessarily reflect the views of any individual or organization.