MINISTRY OF
INDUSTRY AND TRADE

EU - VIET NAM SUSTAINABLE ENERGY
TRANSITION PROGRAMME (SETP)

Global Gateway

Funded by
the European Union

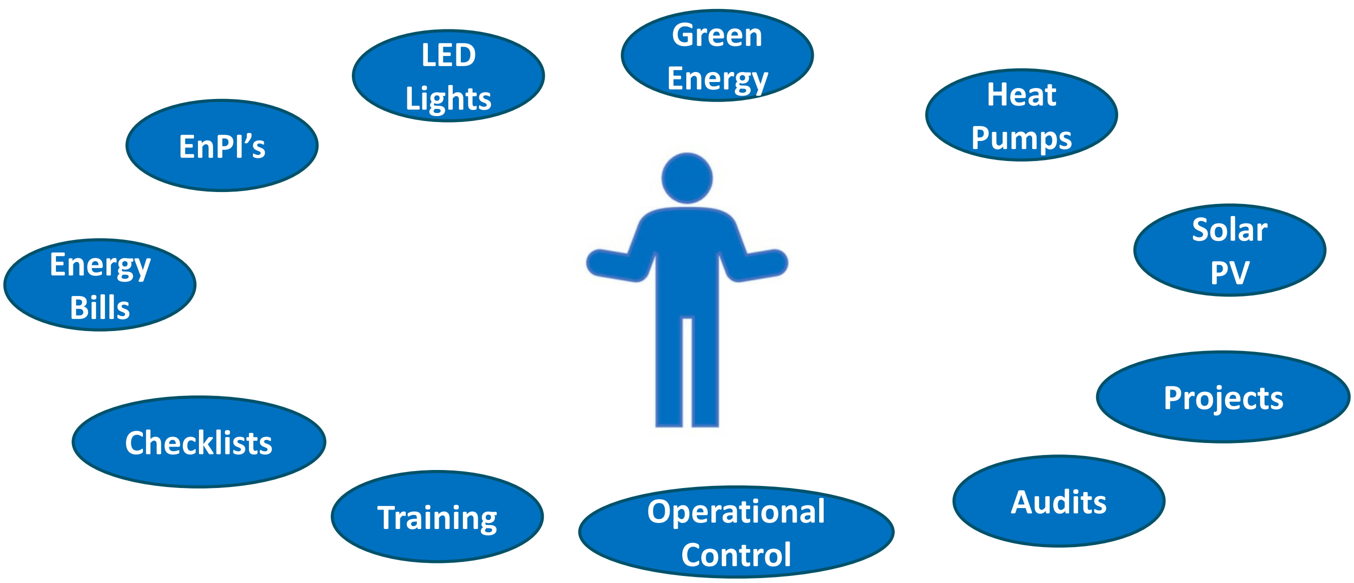
UNIDO

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

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

TRAINING PROGRAMME

SMALL & MEDIUM ENTERPRISES ENERGY EFFICIENCY TRAINERS



Ha Noi, 26 - 28/11/2025

AGENDA

ENERGY EFFICIENCY SMALL & MEDIUM ENTERPRISES TRAINERS TRAINING

From 26/11/2025 to 28/11/2025

Adonis Hotel, 55 Quang Trung, Hai Ba Trung ward, Hanoi

Day 1 - 26/11/2025

Time	Contents	Speakers
8.00-8.30	Registration and welcome	
8.30-8.35	Introduction	UNIDO Project
8.35-8.45	Opening speech	MOIT/UNIDO Project
8.30-10.00	Introduction to Energy Efficiency	International Expert
10.00-10.15	**Tea break**	
10.15-12.00	Energy Planning and Action Plan Development	International Expert
12.00-13.30	**Lunch at the Hotel**	All participants
13.30-15.0	Data analysis	International Expert
15.00-15.15	**Tea break**	
15.15-17.00	Operational Control and Checking	International Expert &Trainees

Day 2: 27/11/2025

Time	Contents	Speakers
8.00-8.30	Day 2 Attendance Sign-In	
8.30-10.00	Steam and Hot Water Boilers	International Expert
10.00-10.15	**Tea break**	
10.15-12.00	Air Compressors and Pumping	International Expert
12.00-13.30	**Lunch at the Hotel**	
13.30-15.00	Refrigeration and Lighting	International Expert
15.00-15.15	**Tea break**	
15.15-16.50	HVAC and Process Reviews	International Expert &Trainees

Day 3: 28/11/2025

Time	Contents	Speakers
8.00-8.30	Day 3 Attendance Sign-In	
8.30-10.00	Effective Training Techniques	International Expert
10.00-10.15	**Tea break**	
10.15-12.00	Effective Training Techniques	International Expert
12.00-13.30	**Lunch at the Hotel**	
13.30-15.00	Unplanned training events and communication styles	International Expert
15.00-15.15	**Tea break**	
15.15-17.00	Business Case and Case Stories	International Expert &Trainees

EU - VIETNAM SUSTAINABLE ENERGY TRANSITION PROGRAMME (SETP)

EE SME Trainer Training

UNIDO International Energy Efficiency and EnMS Training

Day 1

Delivered by: Richard Morrison, Colin Donohue

Housekeeping

- Emergency exits
- Toilets
- Mobile phones
- Breaks
- Lunch
- Please restrict email to break times

Introductions

- Name
- Company
- Energy Management Experience
- What do you expect to learn from this training?

Why are you here?

- Gain additional knowledge about energy efficiency and energy management
- Help to reduce the business environmental impacts
- Identify best practice deployment
- Employee engagement skills
- Save Money

Agenda for Day 1

Day 1 –Energy Efficiency Introduction, Energy Planning & Data Analysis	
08:30 – 10:00	Introduction to Energy Efficiency
10:00 – 10:30	Break
10:30 – 12:00	Energy Planning and Action Plan Development
12:00 – 13:30	Lunch
13:30 – 15:00	Data analysis
15:00 – 15:30	Break
15:30 – 16:30	Operational Control and Checking

Agenda for Day 2

Day 2 – Technical focus	
08:30 – 10:00	Steam and Hot Water Boilers
10:00 – 10:30	Break
10:30 – 12:00	Air Compressors and Pumping
12:00 – 13:30	Lunch
13:30 – 15:00	Refrigeration and Lighting
15:00 – 15:30	Break
15:30 – 16:30	HVAC and Process Reviews

Agenda for Day 3

Day 3 – Training Skills	
08:30 – 10:00	Effective Training Techniques
10:00 – 10:30	Break
10:30 – 12:00	Effective Training Techniques
12:00 – 13:30	Lunch
13:30 – 15:00	Unplanned training events and communication styles
15:00 – 15:30	Break
15:30 – 16:30	Business Case and Case Stories

International Energy Policy

- UN Sustainable Development Goals
- 17 Goals to achieve sustainable development
- Paris Climate Change Agreement
- Limit temp increase to 2^0C
- Vietnam' s National Energy Efficiency Programme (VNEEP) for 2019–2030 (Decision 280/QD-TTg) sets the overarching goals surrounding 8-10% savings of total national energy.

Why do I need to consider energy management?

In your company, who could approve an expenditure of $50,000?

Who can decide in your company to turn on an electrical load of 25kW such as a cooling water pump or an air compressor?

Energy Efficiency is a major opportunity for cost savings

Food Company reduced their natural gas consumption by 12% in the first year

Steel company improved energy performance of its furnace by 5%

Paper company improved overall energy performance by 7%.

Steel company saved 11GWh of fuel by changing process set points.

Industrial Energy Efficiency Benefits

- Energy efficiency has demonstrated, time and again, that
  - ✓ It saves industrial firms money
  - ✓ It increases reliability of operations
  - ✓ It has a positive effect on productivity and competitiveness
  - ✓ It can offer attractive financial and economic returns
  - ✓ Improved security of supply
  - ✓ Improved Corporate Social Responsibility
  - ✓ ….

Then

Why it is not happening?

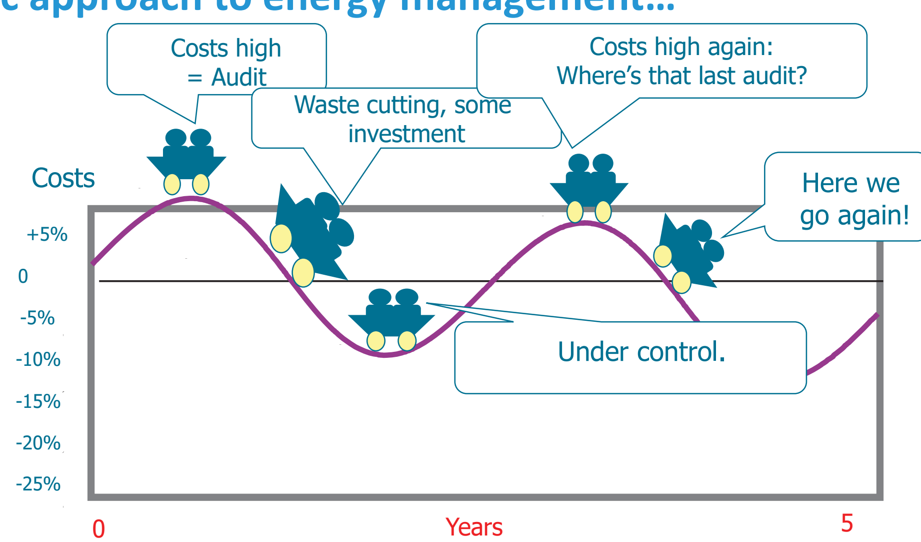
Barriers to Industrial Energy Efficiency

- Management focus is on production and not on energy efficiency
- Lack of information and understanding of financial and qualitative benefits
- Lack of adequate technical skills to assess performance, developing and implementing EE measures and projects
- First costs more important than recurring costs → disconnection between capital and operating budgets
- When EE knowledge exists it very often resides with individuals rather than with the company/organization → sustainability risk
- Poor realization among senior management of the scale of the opportunity
- ……

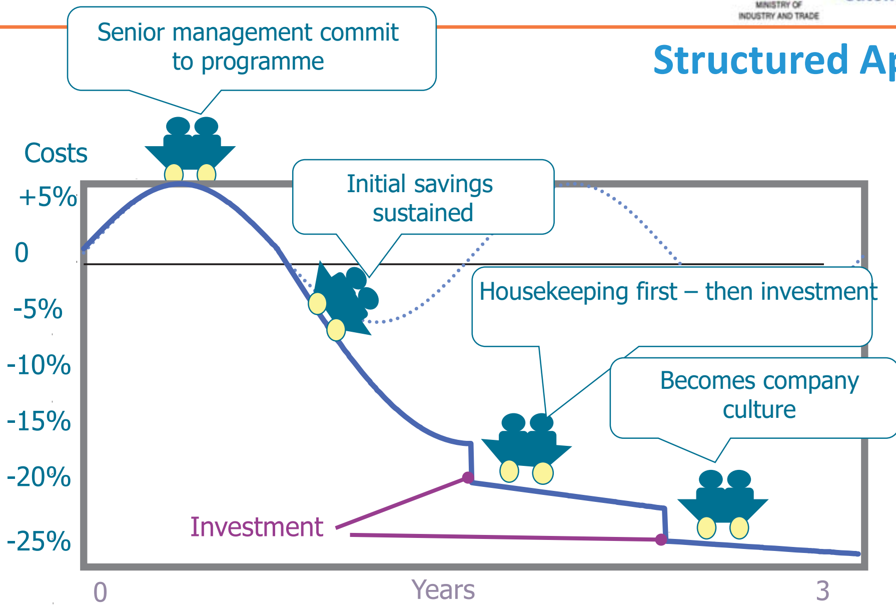
Discussion

Does anyone here think it is difficult to achieve savings of 10% in energy consumption without much financial investment?

Ad hoc approach to energy management…



Structured Approach



Energy Management and Trade

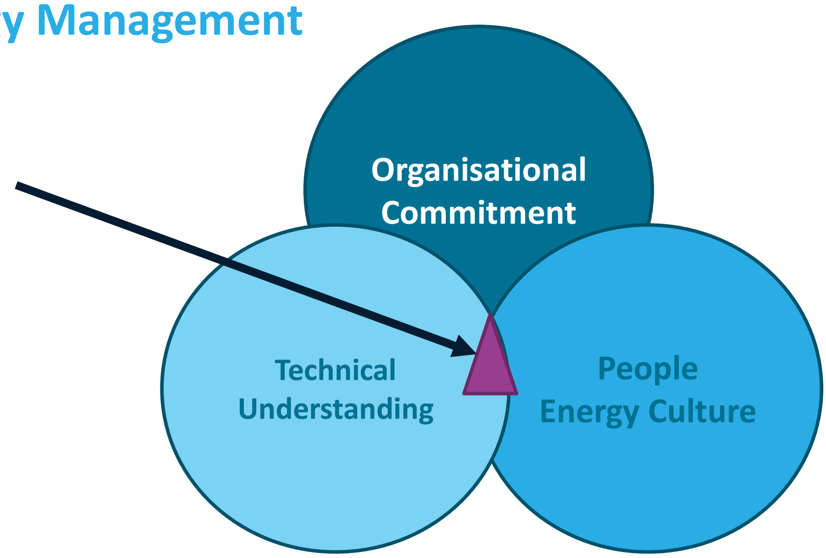
- Companies are demanding participation by their suppliers, for example products being exported to EU customers - this has been happening already for environmental and lean manufacturing (i.e.--Wal-Mart, Toyota)
- Uptake of energy management in the supply chain was driven largely by Western European countries and Japan
- Exporters that position themselves now will be at a competitive advantage
- Structured energy management and taking action also reduces the cost of goods sold.
- In some cases, it is the law
- ....

The Business Case for Energy Efficiency in an SME

- Direct Cost Savings
- Competitiveness and Profitability
- Access to Green finance
- Customer expectations (e.g CBAM)
- Productivity benefits
- Brand and Reputation

Effective Energy Management

Focus on all elements to succeed



Six Step Programme for SME Energy Efficiency

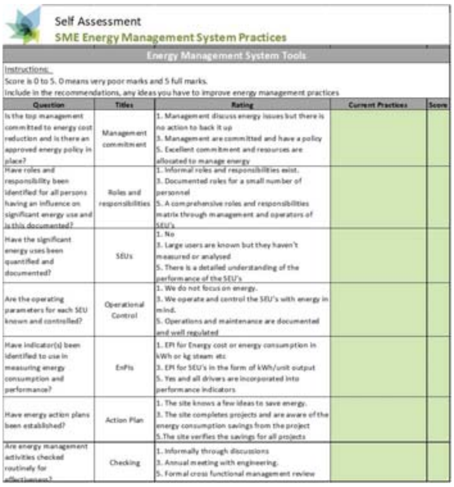
Commit	•Review your current energy management situation •Commit some time and money to making improvements
Identify SEUs	•Understand your energy bills and review usage profile •Understand the large energy users
Monitor (EnPIs)	•Review and track your energy bills •Monitor the usage or performance of the big users
Operational Control	•Focus on the large users •Understand the small number of parameters that can make a big difference to performance
Take Action	•From the list of ideas, create an action plan •Include the Who, What, When and how much we will save in the action plan
Review	•Monitor and review improvements of the project after installation •Review the operation for more improvements

MINISTRY OF INDUSTRY AND TRADE · Global Gateway · Funded by the European Union · UNIDO · UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Self Assessment UNIDO SME EnMS Tool

We will take some time now to complete the self assessment of your organisations energy management practices

10 Minutes



Self Assessment
SME Energy Management System Practices

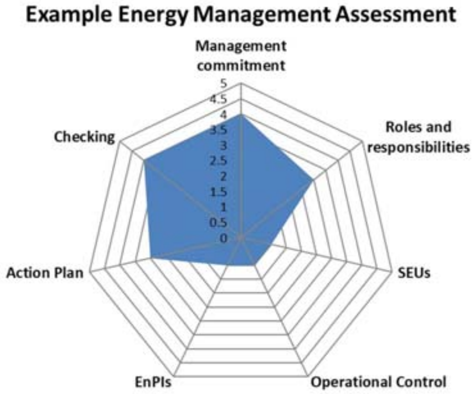
Energy Management System Tools

Instructions:
Score is 0 to 5. 0 means very poor marks and 5 full marks.
Include in the recommendations, any ideas you have to improve energy management practices

Question	Titles	Rating	Current Practices	Score
Is the top management committed to energy cost reduction and is there an approved energy policy in place?	Management commitment	1. Management discuss energy issues but there is no action to back it up 3. Management are committed and have a policy 5. Excellent commitment and resources are allocated to manage energy		
Have roles and responsibility been identified for all persons having an influence on significant energy use and is this documented?	Roles and responsibilities	1. Informal roles and responsibilities exist. 3. Documented roles for a small number of personnel 5. A comprehensive roles and responsibilities matrix through management and operators of SEU's		
Have the significant energy uses been quantified and documented?	SEUs	1. No 3. Large users are known but they haven't measured or analysed 5. There is a detailed understanding of the performance of the SEU's		
Are the operating parameters for each SEU known and controlled?	Operational Control	1. We do not focus on energy. 3. We operate and control the SEU's with energy in mind. 5. Operations and maintenance are documented and well regulated		
Have indicator(s) been identified to use in measuring energy consumption and performance?	EnPIs	1. EPI for Energy cost or energy consumption in kWh or kg steam etc 3. EPI for SEU's in the form of kWh/unit output 5. Yes and all drivers are incorporated into performance indicators		
Have energy action plans been established?	Action Plan	1. The site knows a few ideas to save energy. 3. The site completes projects and are aware of the energy consumption savings from the project 5.The site verifies the savings for all projects		
Are energy management activities checked routinely for effectiveness?	Checking	1. Informally through discussions 3. Annual meeting with engineering. 5. Formal cross functional management review		

Self Assessment Results

- What have you learned from your self assessment?
- What actions should you take to improve energy management practices on site?



Commitment to managing energy

- Give commitment
- Approve an Energy Policy
- Allocate resources
- Assign responsibility
- Give support
- Make decisions

Give Commitment

- Senior management to make improvement commitment
  - What percentage improvement is required or expected?
- Monitor and track the energy bills and performance indicators
- Ensure adequate resources are put in place
- Improvement action plans to be approved
- Should observe energy waste and do something about it.
- Focus on operational control.
- Maintenance of plant to include energy efficiency considerations

Approve an Energy Policy Statement

- Commit to improvement
- Allocation of resources
- Comply with the law
- Eliminate waste
- Design with efficiency in mind
- Purchase with energy efficiency in mind

Allocate Resources

We need to spend some time to identify where money should be spent

Time is the most valuable resource

Need to understand where the money should be spent

We need to have a financial budget to match the energy saving ambition

How much budget should I allocate?

- If the ambition is to save 10% of the energy bill
- If your investment criteria is 4 years or less
- Then the finance you should make available is

$$Investment\ required = Energy\ Bill\ * 4\%\ * 4\ years$$

Is this something that you have in your annual budgeting exercise?

Assign Responsibilities

- We want someone at the top level of the organisation to lead the energy activities
  - Direct the activities
  - Represent energy management at senior level
  - Gain support for energy management
  - This is the energy 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

The level of commitment is dependant on the energy bill

- Depending on the size of your business, you may decide to appoint a staff member as an energy coordinator.
- Your energy coordinator will manage energy in your business and should be able to make key decisions.
- These responsibilities and tasks should be added to their job description.
- The energy coordinator should be enthusiastic, able to communicate well with co-workers and be available to dedicate the time to establish an effective programme.
- This energy coordinator should have an interest in energy management and some knowledge of it.

Examples of staff members who could take on the role of energy coordinator are facilities managers, store managers, office managers, etc.

You will need to look carefully within your own business to assess who is the best candidate.

Energy Coordinator tasks

- Assess current energy use in the company
- Monitor energy usage on an ongoing basis
- Identify areas where savings can be made
- Draw up plan of action for energy savings
- Communicate plan with other staff members
- Coordinate the implementation of the energy plan
- Monitor and evaluate staff behaviour with respect to energy usage
- Coordinate awareness-raising activities for staff
- Report on the energy management programme

Senior Management Key Responsibilities

- Make Commitment
- Commit commitment to paper
- Demonstrate importance of the task
- Provide support and direction
- Walk the talk

Commitment Elements UNIDO SME EnMS Tool

Practical Guide for
Implementing an Energy Management System

Energy Management System Tools

Management Energy Policy Commitment

Senior management are committed to continuous improvement in our energy performance and will strive to improve performance in the coming year by 5%

Roles and Responsibilities

Task	What is required?	Who is Responsible	Frequency	Relevant Documentation
Define scope and boundaries of the EnMS	The scope and boundary includes all electricity and fuel use in the organisation	Senior Manager	Reviewed annually	UNIDO tool
Develop the energy policy	The organisation Energy policy is outlined at the top of this sheet	Senior Manager	Annually	UNIDO tool Cell C7
Set objectives and targets	Objectives and targets to improve performance will be set by management annually on recommendation from energy team	Operations Manager Energy Team	Annually	UNIDO tool Opportunities List
Implement Energy training for SEU operators	Provide training to Maintenance Engineer and operators of the SEU's according to the operation and maintenance criteria	Operations Manager	Annually	UNIDO Tool Operating Criteria
Promote energy awareness	HR Manager to run awareness campaign and to install posters to encourage personnel to turn off equipment when not required	HR Manager	Annually	N/A
Operation of SEUs	Define the operating parameters for office areas and identified significant energy users	Operations Manager	Annually	UNIDO Tool Operating Criteria
Maintenance of SEUs	Define the maintenance parameters for significant energy users	Operations Manager	Annually	UNIDO Tool Maintenance Criteria
Energy Efficient Design	Operations and Engineering to review new design from energy perspective	Management Team	As required	N/A
Monitor energy bills	Monthly review of Utility Bills and record deviations	Energy Team	Monthly	UNIDO Tools Energy Bills
Monitor energy metrics	Monthly review of energy sub-meters if installed and record deviations	Energy Team	Monthly	UNIDO Tools Energy Bills or additional EnPI spreadsheet
System Check	Review of the operation of the system	Energy Team	Monthly	UNIDO Tools Spreadsheet Operations Checks
Review Opportunities progress	Review opportunities Log	Energy Team	Monthly	UNIDO tool Opportunities List
Monitor operational control	Review of the operating parameters of the SEUs and compare to Operating criteria	Energy Team	Daily/weekly	N/A
Participate in management review	Review the system for adequacy and effectiveness	Management Team	Annually	UNIDO Tool

It's Coffee Time

Agenda for Day 1

Day 1 –Energy Efficiency Introduction, Energy Planning & Data Analysis	
08:30 – 10:00	Introduction to Energy Efficiency
10:00 – 10:30	Break
10:30 – 12:00	Energy Planning and Action Plan Development
12:00 – 13:30	Lunch
13:30 – 15:00	Data analysis
15:00 – 15:30	Break
15:30 – 16:30	Operational Control and Checking

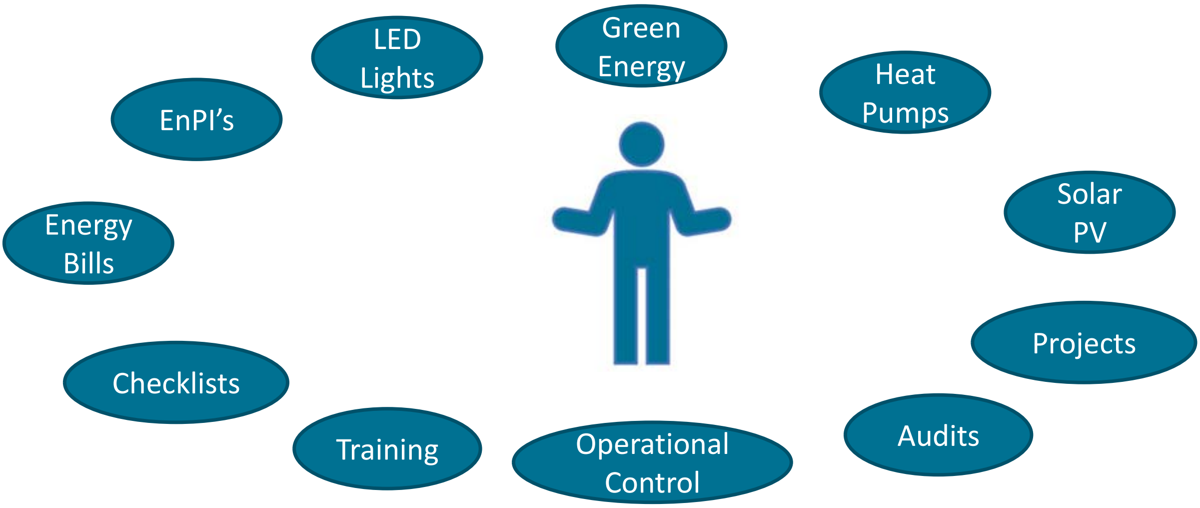
Comply with the Law

- Know your legal requirements and obligations
- Review any voluntary commitments
- Be knowledgeable of any corporate commitments
  - Net Zero, SBTi, CO_2 reductions, energy efficiency reduction of x% etc.
- Carry out an assessment to ensure that you comply with the law.
- Complete in conjunction with any other systems you have on site such as environment or safety systems.

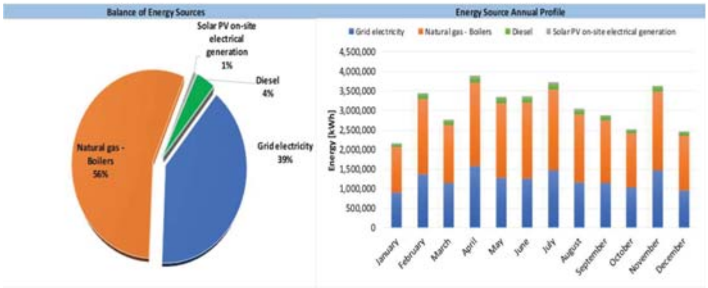
Some Legal Requirements that you should be aware of

Legal Instrument	Year / ID	Purpose / Scope	Key Requirements (that may affect SMEs)	Notes / Applicability to SMEs
Law on Economical and Efficient Use of Energy (EE&C Law) & Law on Amending and Supplementing the EE&C Law	50/2010/QH12 77/2025/QH15	Fundamental law on energy conservation & efficient use	Obligations for organizations to use energy economically, develop annual EE plans, adopt efficient technologies, incorporate EE into production, etc.	Applies broadly to all "organizations, enterprises, individuals" including SMEs
Decree 21/2011/ND-CP (Implementation of EE&C Law)	2011	Detailed implementing regulation of the Law	Defines "major energy users," requires they do energy audits (every 3 years), submit reports, plan EE, report consumption, etc.	SMEs below the "major user" threshold may not be legally mandated, but some obligations cascade down
Circular 25/2020/TT-BCT	2020	Update to energy management rules for large energy-using facilities	Requires large facilities to submit energy use plans and annual / 5-year EE plans, report to DOIT, perform scheduled energy audits, report consumption to local authorities	SMEs that cross "large energy-use" thresholds must comply
Decision 04/2017/QĐ-TTg & Circular 36/2016/TT-BCT	~2016/2017	Energy Efficiency Declarations & labeling for appliances / office equipment	Requires importers / manufacturers of regulated appliances / ICT equipment to submit Declaration of Conformity (DoC) to VNEEP, meet Minimum Energy Performance Standards (MEPS) and labelling rules	Applies to SMEs that manufacture, import, or use regulated appliances
Decree 80/2024/ND-CP (Direct Power Purchase Agreements, DPPA)	2024	Renewable energy procurement regulation	Large electricity consumers may negotiate direct renewable energy purchase agreements (DPPAs) with generators, bypassing some grid constraints	SMEs may benefit if large enough to enter DPPA — more relevant to mid/large firms
Energy Efficiency Standards / MEPS & Labelling Regulations	Various (Decision, TCVN standards)	Defines minimum efficiency standards for electric motors, lighting, appliances, HVAC, etc.	Regulated equipment must meet Minimum Energy Performance Standards (MEPS) and be compliant with national test / labelling standards (e.g. TCVN norms)	Affects SMEs that procure, install, or import these regulated items

Now that we comply with the law, where do we start?



Determining Energy Sources



Cat.	Energy sources	Energy [kWh]	Cost [VND]	Emissions [tCO_2]
Electricity	Grid electricity	14,722,082	2,649,975,000	4,888
	Solar PV on-site electrical generation	270,000	-	-
Thermal	Natural gas - Boilers	20,750,824	1,037,541,000	4,233
Transport	Diesel	1,452,558	261,460,000	383
Total		37,195,463	3,948,976,000	9,504

- Data for all energy sources should be collected on an ongoing basis.
- Energy usage, costs and emissions should be known by the business.

Energy Bills

Energy Bills good practice

- Know the size of your bills
- Be able to read them
- Identify avoidable charges
- Know what to expect from your bills
- Have an approvals process for the energy units in the bills

Energy Bills, move from:

- they just get paid
- only reviewing cost
- budget exercise
- annual discussion

Reading your Electricity Bill

- Billing Period

- Peak electricity consumption
- Regular electricity consumption
- Off-peak electricity consumption

- Peak unit price (example 3,314 VND/kWh)
- Regular unit price (example 1,809 VND/kWh)
- Off-peak unit price (example 1,184 VND/kWh)

Mục đích sử dụng điện: 100 % Sản xuất - Giờ bình thường; 100 % Sản xuất - Giờ cao điểm; 100 % Sản xuất - Giờ thấp điểm

Cấp điện áp sử dụng: Dưới 380V

CÔNG TƠ ĐO ĐẾM	HỆ SỐ NHÂN	CHỈ SỐ MỚI	CHỈ SỐ CŨ	ĐIỆN TIÊU THỤ (kWh)
20007413				
Khung giờ cao điểm	300	2.552	2.532	6.000
Khung giờ bình thường	300	7.931	7.878	15.900
Khung giờ thấp điểm	300	3.371	3.344	8.100

KHUNG GIỜ MUA ĐIỆN	ĐƠN GIÁ (đồng/kWh)	SẢN LƯỢNG (kWh)	THÀNH TIỀN (đồng)
Khung giờ bình thường	1.809	15.900	28.763.100
Khung giờ cao điểm	3.314	6.000	19.884.000
Khung giờ thấp điểm	1.184	8.100	9.590.400

Purpose of electricity use: 100% Production - Normal Hours; 100% Production - Peak Hours; 100% Production - Off-peak Hours

Voltage level used: Under 380V

METER	NEW INDEX	OLD INDEX	MULTIPLIER	ELECTRICITY CONSUMPTION (kWh)
20007413				
Rush hour	300	2.552	2.532	6.000
Regular time frame	300	7.931	7.878	15.900
Off-peak hours	300	3.371	3.344	8.100

ELECTRICITY PURCHASE TIME FRAME	UNIT PRICE (VND/kWh)	OUTPUT (kWh)	AUTHENTICITY (VND)
Regular time frame	1.809	15.900	28.763.100
Rush hour	3.314	6.000	19.884.000
Off-peak hours	1.184	8.100	9.590.400

UNIDO SME EnMS Tool

Practical Guide for
Implementing an Energy Management System

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

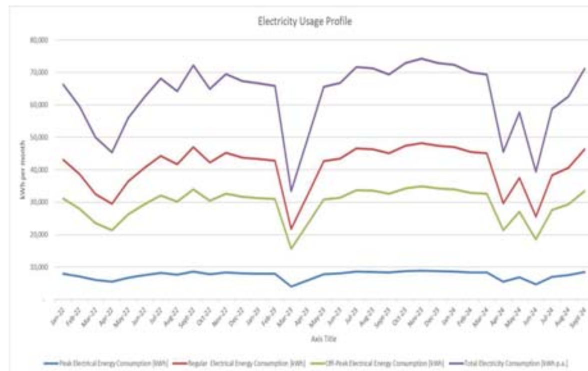
Energy Management System Tools

Energy Bills

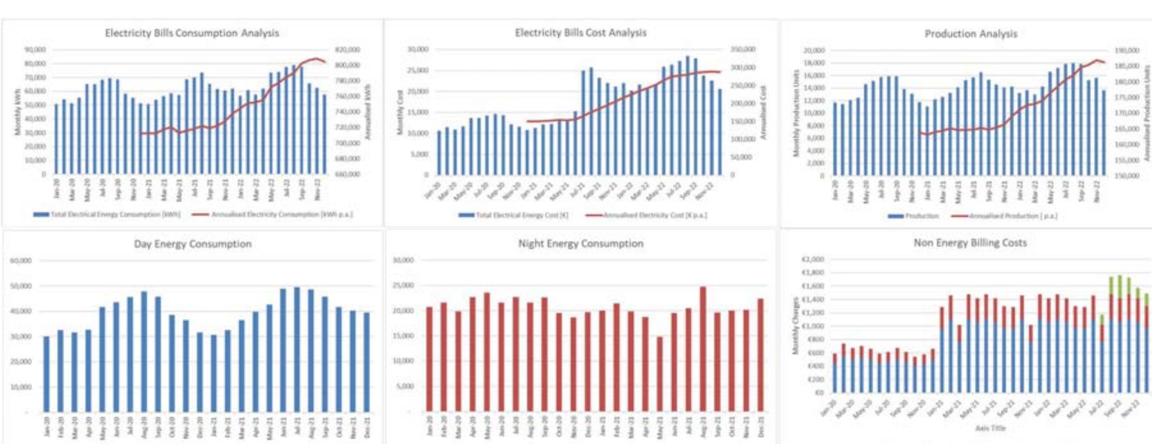
Month	Electrical Energy Consumption [kWh]	Electrical Energy Cost [VND]	Thermal Energy Consumption [kWh]	Thermal Energy Cost [€]	Production Activity	Annualised Electricity Consumption [kWh p.a.]	Annualised Electricity Cost [VND p.a.]	Annualised Thermal Consumption [kWh p.a.]	Annualised Thermal Cost [VND p.a.]	Annualised Production Activity
Jan-22	66,220	218,526	28,533	31,386	28,533					
Feb-22	59,550	196,515	22,558	24,814	22,558					
Mar-22	49,940	164,802	7,117	7,829	7,117					
Apr-22	45,320	149,556	18,295	20,125	18,295					
May-22	55,940	184,602	26,059	28,665	26,059					
Jun-22	62,480	206,184	31,253	34,378	31,253					
Jul-22	68,200	225,060	30,213	33,234	30,213					
Aug-22	64,200	211,860	29,297	32,227	29,297					
Sept-22	72,270	238,491	15,529	17,082	15,529					
Oct-22	64,900	214,170	32,005	35,206	32,005					
Nov-22	69,520	229,416	31,843	35,027	31,843					
Dec-22	67,340	222,222	32,018	35,220	32,018	745,880	2,461,404	304,720	335,192	304,720
Jan-23	66,660	219,978	28,301	31,131	28,301	746,320	2,462,856	304,488	334,937	304,488
Feb-23	65,890	217,437	30,447	33,492	30,447	752,660	2,483,778	312,377	343,615	312,377
Mar-23	33,440	110,352	3,525	3,877	3,525	736,160	2,429,328	308,785	339,663	308,785
Apr-23	49,500	163,350	9,693	10,662	9,693	740,340	2,443,122	300,183	330,201	300,183

Detailed Electricity Breakdown

- Useful to see trends in consumption across the various periods
- Peak V Off-peak
- Are there opportunities to load shift?
- Should off peak be smaller?



Electricity Billing trend analysis for larger users



Significant Energy Users

NOW THAT WE KNOW THE ENERGY USAGE PROFILE FROM THE BILLS

WE NEED TO KNOW WHERE THE ENERGY IS USED.

IDEALLY WE NEED TO IDENTIFY 80% OF THE ENERGY IN THE FACILITY

PARETO PRINCIPLE, 80% OF ENERGY IS USED IN 20% OF USERS

Identify SEUs

- Focus on small number of big users
- If we focus on too many users, effort is diluted
- We can spend a lot of time prioritising the largest energy using areas
- Consider metering
- Consider responsibility
- Consider knowledge and experience

Significant Energy User Identification

Complete this activity for each energy source separately, i.e. electricity first, then thermal energy

Do we have sub metering for our energy sources?

Ideal if on a monitoring system.

Need to determine if the data is correct.

Do we have local metering?

Are there manual utility readings available?

Are they reliable?

Do we need to complete engineering estimates?

Motor list.

Run hours.

Load factors.

Energy consumption can be quantified from Equipment Lists

Need description of the equipment

a) Nameplate data has installed kW

b) Estimated or measured load factor

c) Estimated or known operating hours

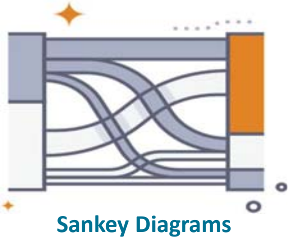
- Energy used p.a. = (a) x (b) x (c)
- e.g. 75 kW Air Compressor with a load factor of 65% operating 3120 hrs p.a. (12*5*52)
- Energy used p.a. = (a) x (b) x (c) =75 X 0.65 X 3120 = 152,100kWh

Example Energy Cost Calculation

- Calculate the operating cost of the following lighting load
  - ✓100 light fittings,
  - ✓45 watts per fitting
  - ✓Load factor 100%
  - ✓Operating Hours 4,250 hrs
  - ✓AUP of 3,100 VND/kWh
- Energy used p.a. = Load x Load Factor x Operating Hours
- Energy used p.a. = 100*.045 x 1 x 4250
- Energy used p.a. = 19,125 kWh p.a.
- Energy Cost p.a. = 59,287,500 VND

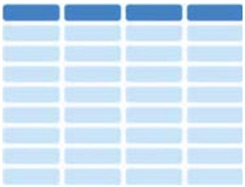
Developing an Energy Balance

Pie Charts



Sankey Diagrams

Pareto Analysis



Tables

- Many methods of demonstrating an energy balance.
- The method is not important as long as the detail is included.
- The company needs to be able to outline where the contents of the energy balance came from including:
  - Data Sources.
  - Assumptions Made.
  - Factors Used.

People that can Impact energy of the Significant Energy Users

- What people can significantly influence the following equipment?

✓ HVAC Systems
✓ Compressed Air systems
✓ Canteen energy consumption
✓ Lighting loads
✓ Production equipment
✓ Transport vehicles

Significant Energy User Template UNIDO SME EnMS Tool

Practical Guide for
Implementing an Energy Management System

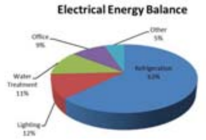
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Energy Management System Tools

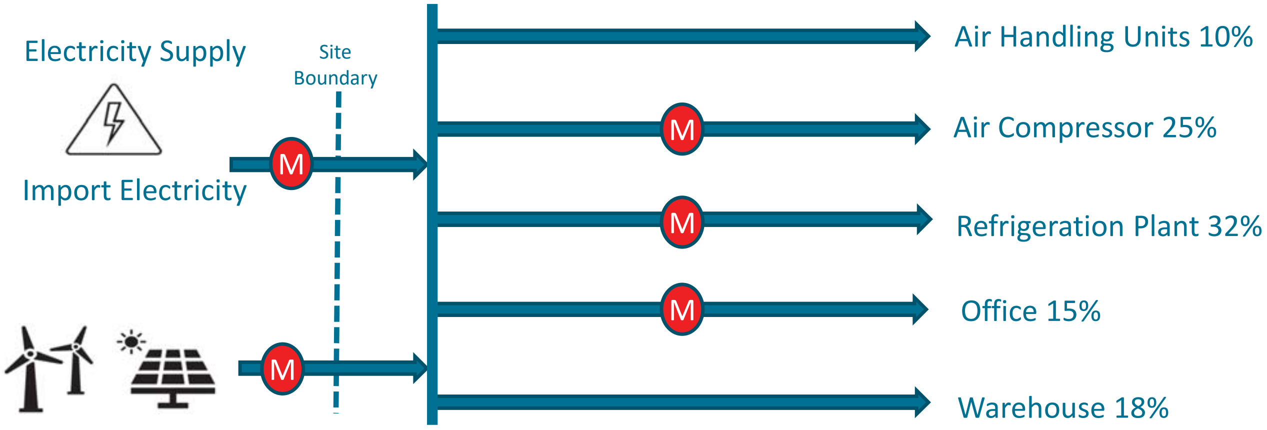
Significant Energy Uses (SEU) List

Electricity

ID	Name of SEU	What are the main drivers?	Is the SEU metered? Auto/ Manual	kWh p.a.	% of Overall Usage	Who influences the energy use? (To be Trained)	Are Influencers Trained in Efficient Operation and Maintenance?	EnPI	Means of determining energy breakdown	Operation Control
1	Refrigeration	Weather and Production	No	421,834	55%	Production operator and supervisor	Yes	N/A	UNIDO Report	Insulation in place, Equipment turned off, Set points correct
2	Lighting	N/A	No	76,697	10%	All personnel	Yes	N/A	Estimation	Lighting off at break times Motion sensors operating Signs up for awareness
3	Water Treatment	Production output MVA	No	76,697	10%	Production operator and supervisor	No	N/A	Estimation	No leaks
4	Office	N/A	No	61,358	8%	All personnel	Yes	N/A	Estimation	PC's off when not in use Two sided printing AC set points as per criteria
5	Other			35678	5%		N/A	N/A	Estimation	N/A



Electrical Energy Map



Thermal Energy Balance

- Thermal meters are more expensive
- Thermal meters can be unreliable
- Typically less meters installed
- Can be a challenge to quantify significant thermal users.
- Consider engineering estimates, nameplate data, condensate return meters, plant experience, etc.
- Do not rush out to procure meters initially

Appropriate Data Sources

Energy Bills

Dockets, Receipts, Invoices

Monitoring & Targeting Systems

Onsite Measurements

Energy Provider Data

What others?

Significant Energy User Best Practice

- review each energy source separately
- strive to account for 80% of energy
- aligned to your organisation's responsibilities
- Challenge current practices
- Identify opportunities in
  - Control,
  - responsibilities,
  - current practices,
  - operational setpoints,
  - replacement opportunities,
  - Etc.

What are the Largest Energy Users in your facility?

How will you identify the largest energy users in your organisation?

Who do you need to get assistance from to complete this task?

Sources of Opportunities for Improvement

- Energy Audits
- Operations Review
- Maintenance Staff
- Service Providers
- Training Events
- On Line search tools

Opportunities Identification in Day 2

Layer	Definition	Ventilation Example
Management	The on-going management of energy performance of the system	EnPIs, Awareness campaigns, training on efficient operations
Operation & Maintenance	The on-going operation and maintenance of the equipment	Optimal operational control, consider manufacturer recommended maintenance
Control	The control applied to the equipment	Passive vents, Automation systems, switches
Equipment	The constituent parts of the process	Technology selected, vents, fans, dampers, ducting, fresh air vents, room vents.
Process	The means by which the energy service is delivered	Natural ventilation / Mechanical ventilation
Energy Service	The desired outcome that necessitates the consumption of energy	Fresh air requirements in the space, pressurisation, pressure profile, etc.

Opportunities for Improvement

Which Opportunity would you implement first?

Opportunities List / Action Plan UNIDO SME EnMS Tool

Practical Guide for
Implementing an Energy Management System

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Energy Management System Tools

Opportunities List

ID	Description of Opportunity	Capital Cost	Potential payback (years)	Estimated / Actual Savings				Person Responsible	Target Completion Date	Status	Method of estimating savings
				kWh elec	kWh fuel	CO2	Financial Saving				
1	Lighting control in cold storage and freezing rooms.	0	-				1		2017	Idea	Calculation
2	Use of Entrance Room rather than the side door to manufacturing space to conserve energy	0	-				1		2017	In progress	Calculation
3	Rationalise the use of space in the production hall and minimise the use of AC systems	0	-				1		2017	Complete	Measurement
4	etc.	0	-				1			Cancelled	
5		0	-				1				
6		0	-				1				
7		0	-				1				
8		0	-				1				
9		0	-				1				
10		0	-				1				
11		0	-				1				
12		0	-				1				
13		0	-				1				
14		0	-				1				
15		0	-				1				
12		0	-				1				

Action Plan Prioritisation

Need to prioritise opportunities into action plans,

Consider

Capex availability	Return on Investment	Ease of implementation	Barriers	Business Needs	Client expectations	Business Continuity

Action Plan Development Process

SEU	Ideas	Priorotisation	Action
• Identify the Largest Energy Users • Challenge the SEU's to identify ideas	• Opportunities Register • Technical Operational People	• Prioritise based on Objectives • Resources etc.	• Approve the Action Plan • Implement the plan and review

Contents of an Action Plan

- Action plans should include
  - ➢ Description of Action Plan
  - ➢ Responsibility
  - ➢ How it will be carried out
  - ➢ Target completion date
  - ➢ Method of how improvement will be verified
  - ➢ Needs to be documented

See you in 45 minutes!

Agenda for Day 1

Day 1 –Energy Efficiency Introduction, Energy Planning & Data Analysis	
08:30 – 10:00	Introduction to Energy Efficiency
10:00 – 10:30	Break
10:30 – 12:00	Energy Planning and Action Plan Development
12:00 – 13:30	Lunch
13:30 – 15:00	Data analysis
15:00 – 15:30	Break
15:30 – 16:30	Operational Control and Checking

Data Analysis

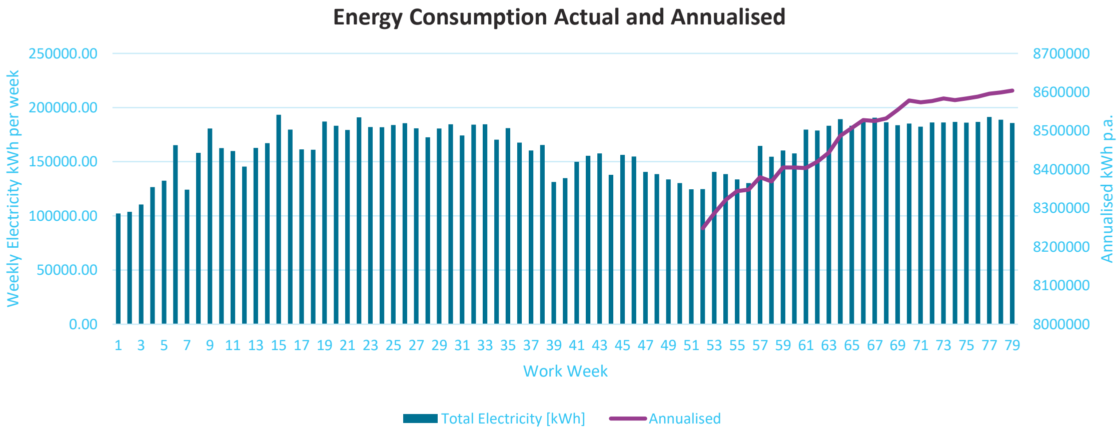
- 15 minute or half hourly data may be available.
- The site should be able to understand all potential data sources and how to use them to determine opportunities for improvement.

02:00	02:15	02:30	02:45	03:00	03:15	03:30	03:45	04:00	04:15
,254	5,327	5,327	5,319	5,309	5,292	5,289	5,327	5,298	5,304
,336	5,398	5,389	5,404	5,375	5,368	5,357	5,307	5,207	5,196
,932	4,996	5,010	5,051	5,093	5,031	5,090	5,114	5,084	5,046
,931	4,850	4,931	4,893	4,882	4,852	4,867	4,896	4,907	4,932
,201	5,078	5,054	5,042	5,052	5,102	5,108	5,076	5,049	5,046
,844	4,908	4,831	4,793	4,768	4,864	4,866	4,759	4,738	4,794
,090	4,031	4,037	4,043	3,958	3,952	3,838	3,870	4,221	4,419
,960	4,952	5,031	5,028	5,130	5,143	5,110	5,145	5,122	5,102
,896	4,903	4,869	4,973	4,960	4,923	4,934	4,894	4,907	4,943
,662	3,688	3,820	3,961	4,049	4,142	4,234	4,328	4,239	4,260
,002	5,037	5,099	4,905	4,831	4,931	4,922	4,835	4,774	5,090
,124	5,093	5,039	4,992	4,932	4,958	4,964	5,116	5,116	5,067
,867	4,869	4,841	4,825	4,982	5,011	5,014	5,032	5,069	5,119
,257	5,248	5,304	5,334	5,260	5,262	5,277	5,280	5,254	5,058
,315	4,263	4,284	4,274	4,243	4,345	4,210	4,154	4,252	4,158
,586	3,597	3,615	3,610	3,585	3,538	3,550	3,629	3,562	3,469
,319	5,328	5,321	5,348	5,360	5,310	5,284	5,300	5,407	5,272
,057	5,117	5,098	5,084	5,146	5,227	5,254	5,321	5,339	5,316
,913	4,888	4,900	4,917	4,955	4,899	4,920	4,961	4,940	4,963
,398	5,312	5,294	5,281	5,240	5,154	5,107	5,087	5,008	4,992
,435	5,445	5,406	5,388	5,366	5,401	5,377	5,371	5,286	5,262
,134	5,098	5,102	5,105	5,139	5,093	5,133	5,154	5,124	5,110
,477	5,371	5,304	5,322	5,280	5,216	5,290	5,341	5,347	5,433
,605	4,679	4,665	4,642	4,702	4,720	4,703	4,808	4,866	4,894
,764	4,791	4,773	4,826	4,815	4,680	4,712	4,720	4,720	4,740
,802	4,803	4,803	4,820	4,852	4,975	5,087	5,098	5,199	5,160
,313	5,315	5,278	5,262	5,269	5,243	5,196	5,122	5,110	5,043
,650	4,847	4,823	4,734	4,632	4,510	4,529	4,541	4,542	4,683
,001	5,036	5,002	5,017	5,058	5,046	5,055	5,048	5,057	5,131
,031	5,020	5,168	5,166	5,168	5,157	5,139	5,080	5,180	5,172

Demonstration

The following demo shows how to use data in an analysis in order to identify energy saving improvements

Energy Consumption Weekly and Annualised



Energy performance metrics including EnPIs

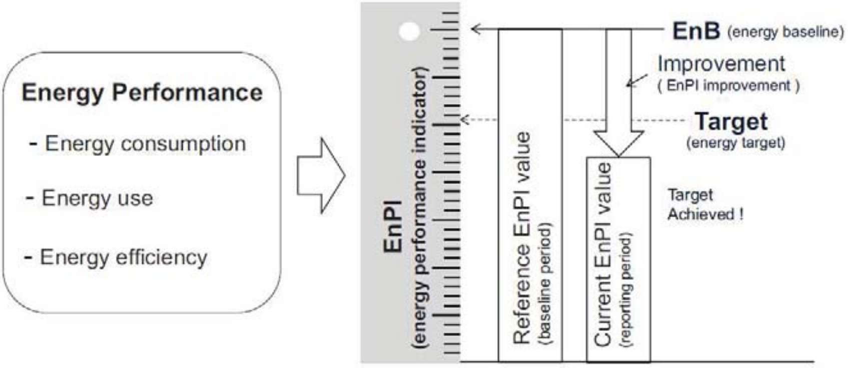


Figure 1 — Relationship between energy performance, EnPIs, EnBs and energy targets

Figure courtesy ISO (ISO 50006)

Regression Analysis Overview

DATA ANALYSIS

RUN CHART

ANNUALISED ANALYSIS

SIMPLE REGRESSION WITH ONE VARIABLE

MULTI-REGRESSION WITH MULTIPLE VARIABLES

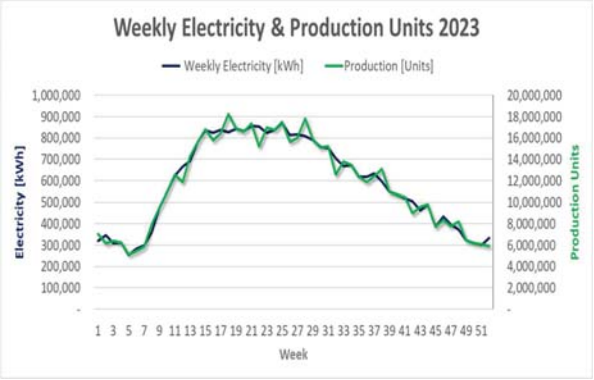
ITEMS TO TAKE CARE OF WHEN USING THE ANALYSIS

Small SME starting on energy management journey

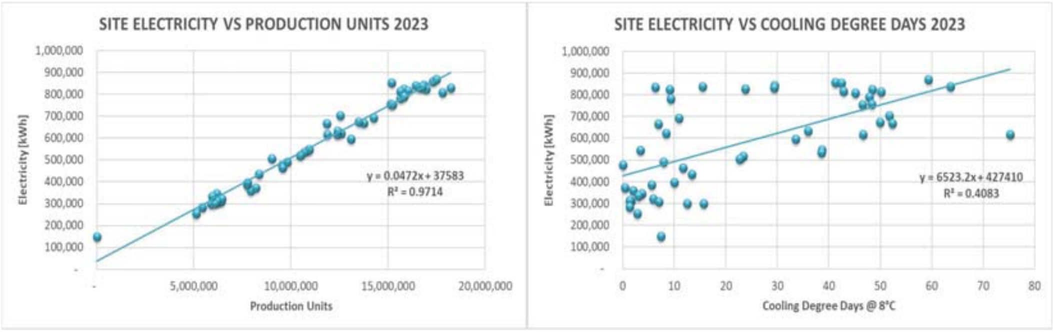
Larger SME with significant energy bills

Steps: Energy Variable Review

- There should be an understanding of the drivers of energy at an organisational and significant energy user level.
- This can be achieved in several ways e.g. line diagrams, regression analysis.
- It is important to consider correlation versus causation through discussions with personnel.



Steps: Single variable linear regression analysis



- Regression analysis gives the best insight into whether variables are deemed statistically relevant.
- This form of analysis also allows for the analysis of baseloads, energy performance, outliers.
- What questions does the analysis above raise?

Regression Revisited - Straight line formula

- Y = mX + C
- Energy (E) = Factor (F) * Driver (D) + Constant (c)
- E = FD+c
- In the previous case:

  Electricity = 0.0472* Production Units + 37,583
- This formula can be used to predict expected consumption for any given driver
- We can compare **predicted vs. actual usage** to indicate changes in performance.

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

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

Steps: Multi-variable linear regression analysis

Site Electricity Vs Production Units & CDD's 2023

Regression Statistics	
Multiple R	0.988269046
R Square	0.976675707
Adjusted R Square	0.975723695
Standard Error	32049.06984
Observations	52

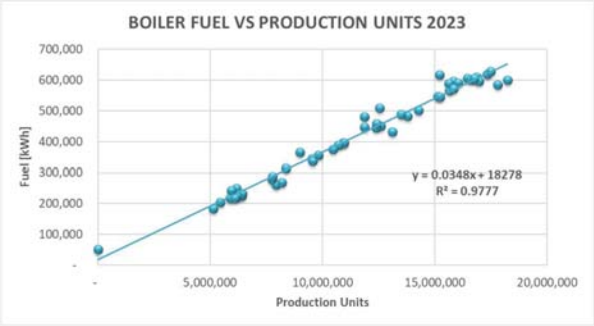
ANOVA

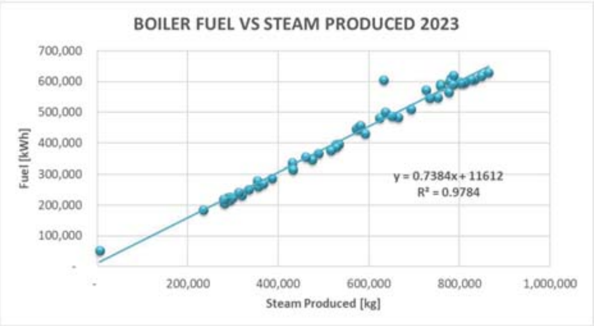
	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	2.10751E+12	1.05375E+12	1025.906958	1.02638E-40
Residual	49	50330001007	1027142878		
Total	51	2.15784E+12			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	17599.31037	13941.76826	1.262344205	0.212800074	-10417.72189	45616.34263	-10417.72189	45616.34263
Production [Units]	0.047993762	0.0013956	34.38933551	5.70373E-36	0.045189199	0.050798326	0.045189199	0.050798326
Cooling Degree Days @ 8°C	319.754026	279.5422784	1.143848536	0.258243819	-242.0072145	881.5152664	-242.0072145	881.5152664

- Factoring multiple variables into one single analysis gives further insight into the energy drivers.
- Discussions should be held with site personnel to determine all potential drivers, and drivers should be tested to determine their relevance.

Steps: Review Energy Generation & Energy Use using regression





- Variables that drive both site level energy, and SEU energy should be analysed.
- This can allow for both the review of energy performance relative to site activity, and the review of equipment performance.
- **What questions does the analysis above raise?**

Statistical Terms

P-value, the P-value represents the probability that there is NOT a statistically significant relationship between variables. Therefore, a low P-value (preferably below 0.05) can be interpreted to indicate that it is unlikely that two variable are NOT related.

For example, lets say a farmer collected data on the number of chickens on his farm and the number of eggs produced for any given month. He determined that for his given data set the P-Value was of 0.03. What does this mean? From this we can conclude that there is a 3 in 100 chance that the number of egg produced is NOT related to the number of chickens.

R^2 is the measurement of how well a regression model fits actual data points. The value can range from 0 to 1 where 1 represents a perfect fit of the regression to the actual data.

In Summary, since we want to consider variables that both have a statistically significant impact on the energy consumed and that we can effectively model, both the P-value and R^2 will be considered.

Statistical Terms

Interpretation

- P-value for each X and Y
- P-value is the probability that the X and Y pair are not correlated.
- If the p-value is less than 0.05, there is less than a 5% chance that the X and Y pair are not correlated (95% confidence interval).
- Determine if results make sense

Statistical Terms Interpretation

1) Review the p-values at the bottom of the data entry chart. Ensure the p-value for each variable is less than 0.05. Variables that have high p-values should be removed from the analysis (remove the variable as an input and rerun the analysis).
2) The F-test is a test of model significance. Ensure the p-value for the model is less than 0.05.
3) Review the R^2 value for the regression equation. (The R^2 value quantifies the amount of variation in the dependent variable, Y, which is explained by the regression equation. Ideally, you would like for the R^2 value to be high, indicating that you have a model that explains a large portion of the variation in energy consumption.)
4) If the R^2 value for the model is low, review the factors to determine if a factor that can impact energy usage has been overlooked.
5) Determine, based on process knowledge, whether the regression makes sense.

It's Coffee Time

Agenda for Day 1

Day 1 –Energy Efficiency Introduction, Energy Planning & Data Analysis	
08:30 – 10:00	Introduction to Energy Efficiency
10:00 – 10:30	Break
10:30 – 12:00	Energy Planning and Action Plan Development
12:00 – 13:30	Lunch
13:30 – 15:00	Data analysis
15:00 – 15:30	Break
15:30 – 16:30	Operational Control and Checking

Operational Control Very Significant Step

- ✓ Are we operating and maintaining our SEUs efficiently?
- ✓ Very strong link to training and competence
- ✓ Often poor knowledge or appreciation of energy impacts among technical personnel
- ✓ Investigated when identifying and reviewing SEUs
- ✓ Service delivery needs to be reliable and efficient
    - ✓ Primary focus is always on reliability

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

Operational Control

This is aligned with checks of 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 may identify additional training needs for operations personnel

Operational Control

Increasing refrigeration condenser pressure for improved control and stability	Simultaneous heating/cooling in HVAC	Pumps running 24/7 unnecessarily	Low TDS on boilers
High baseload	Air Conditioning set to inappropriate temperatures	Leaks	Excessive compressed air pressure

Any other examples in your company?

Operating Criteria Discussion

What would be the energy related operating criteria for the following:

- Production Spaces
- Office Areas
- Production Equipment
- Other areas that the participants are familiar with

Operational Control UNIDO SME EnMS Tool

Practical Guide for
Implementing an Energy Management System

Energy Management System Tools

Critical Operating Parameters

SEU (inc use)	Operational Control Check	Parameter	Eng Units	Normal set point or value	Upper Limit	Lower Limit	Who needs to be informed of these values?	Who needs to be informed of deviations?	Operational Control Not
Refrigeration Compressor 1	Ensure refrigeration plant is turned off	HP	Bar	15	17	13	operators	supervisor	
Refrigeration Compressor 1		IP	Bar	8	9	7	operators	supervisor	
Refrigeration Compressor 1		OP	Bar	9	10	8	operators	supervisor	
Refrigeration Compressor 2		HP	Bar	15	17	13	operators	supervisor	
Refrigeration Compressor 2		IP	Bar	8	9	7	operators	supervisor	
Refrigeration Compressor 2		OP	Bar	9	10	8	operators	supervisor	
Refrigeration Compressor 3		HP	Bar	15	17	13	operators	supervisor	
Refrigeration Compressor 3		IP	Bar	8	9	7	operators	supervisor	
Refrigeration Compressor 3		OP	Bar	9	10	8	operators	supervisor	
Freezer 1		Temperature	Degree C	-19	-19.5	-16	operators	supervisor	
Freezer 2		Temperature	Degree C	-5	-5.5	-3	operators	supervisor	
Blast Freezer		Temperature	Degree C	-40	-40	-35	operators	supervisor	
Packing Hall		Temperature	Degree C	5	7	3	operators	supervisor	
Freezer 1		Defrost Frequency	Hrs	12	24	8	operators	supervisor	
Freezer 2		Defrost Frequency	Hrs	12	24	8	operators	supervisor	
Blast Freezer		Defrost Frequency	Hrs	12	24	8	operators	supervisor	
Office Area AC Units		Temperature	Degree C	26	28	25	Office Staff	Management	
etc.									

Maintenance

- The primary purpose of maintenance has been reliability & availability.
- If equipment is properly maintained it will be energy efficient also.
- Reactive maintenance **will** waste energy

- The cost of the energy will often be more than the maintenance cost
- All large energy users need to be maintained correctly

- Engage with external service contracts & internal maintenance staff

- Ask for opportunities for improvement in the equipment.

Operations and Maintenance

Change is Uncomfortable and hard to sustain

"We have always been operating (maintaining) things this way"

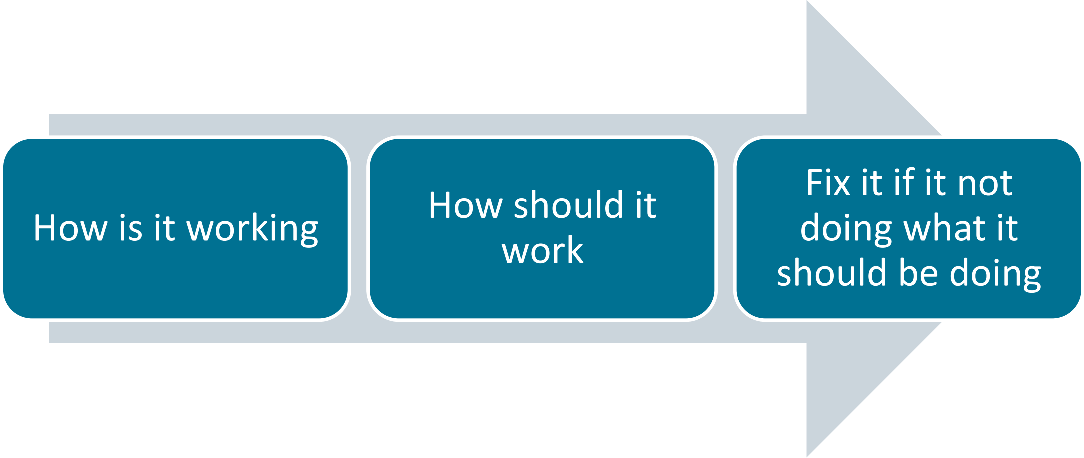
"Why do we need to change?"

"Production is critical – if we change something we may affect production"

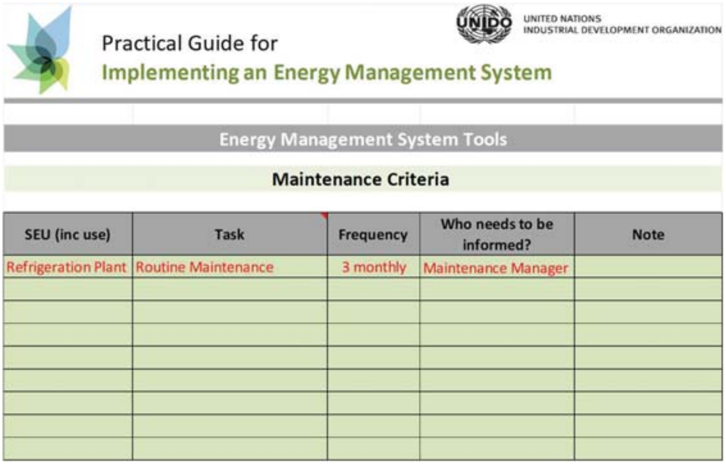
Discussion

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

Maintenance Activities



Maintenance Criteria UNIDO SME EnMS Tool



UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

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
Refrigeration Plant	Routine Maintenance	3 monthly	Maintenance Manager	

Energy Efficiency in Design and Procurement

Ask yourself how long will this design be in place?

What are my long term energy efficiency and decarbonisation objectives and is this design aligned to the objective?

Challenge the design team .
Why is it being done like this?
Why, Why? Why?

Spend the money wisely now or spend much more over the lifetime of the equipment

Energy Awareness

- All staff need to be aware of Energy Management
- All staff need to be aware of the company 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

Checking that the System is working

1

Check Commitment

- Is the company still committed
- Is there sufficient resources and buy-in to this?

2

Check SEU Performance

- Are the Energy Bills being tracked and managed
- Is the energy performance of the SEU's OK

3

Check Action Plans

- Is progress being made
- Are savings being delivered

4

Check Operational Control

- Setpoints
- Schedules
- Logs

Checking

- 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

Checking Performance

- We have energy trends for the bills and maybe the SEUs
- We could 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 check energy consumption V expected values
- Typically weekly activity

Significant Deviations

- A major difference in the measurement compared to expected.
- The equipment or process is not performing as expected from EnPI, Operational limits, etc.
- Record in an issues tracker and investigate the reason
- Take appropriate action
- Keep a record

Checking or Review UNIDO SME EnMS Tool

Practical Guide for
Implementing an Energy Management System

Energy Management System Tools

Issues

ID	Description	Date Identified	Action Taken	Resp	Target Completion	Actual Completion
1	Electricity Consumption significantly increased in March	02/05/2018	Investigation identified additional production requiring refrigeration plant to run for two weekends in March	Richard Morrison	05/05/2018	15/05/2018
2						
3						
4						
5						
6						
7						
8						
9						
10						

Recap Six Step Programme for SME Energy Efficiency

Commit
- Review your current energy management situation
- Commit some time and money to making improvements

Identify SEUs
- Understand your energy bills and review usage profile
- Understand the large energy users

Monitor (EnPIs)
- Review and track your energy bills
- Monitor the usage or performance of the big users

Operational Control
- Focus on the large users
- Understand the small number of parameters that can make a big difference to performance

Take Action
- From the list of ideas, create an action plan
- Include the Who, What, When and how much we will save in the action plan

Review
- Monitor and review improvements of the project after installation
- Review the operation for more improvements

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.

Questions?

Thank you!

See you tomorrow

EU - VIETNAM SUSTAINABLE ENERGY TRANSITION PROGRAMME (SETP)

EE SME Trainer Training

UNIDO International Energy Efficiency and EnMS Training

Day 2

Delivered by: Richard Morrison, Colin Donohue

Housekeeping

- Emergency exits
- Toilets
- Mobile phones
- Breaks
- Lunch
- Please restrict email to break times

Recap Six Step Programme for SME Energy Efficiency

Commit	•Review your current energy management situation •Commit some time and money to making improvements
Identify SEUs	•Understand your energy bills and review usage profile •Understand the large energy users
Monitor (EnPIs)	•Review and track your energy bills •Monitor the usage or performance of the big users
Operational Control	•Focus on the large users •Understand the small number of parameters that can make a big difference to performance
Take Action	•From the list of ideas, create an action plan •Include the Who, What, When and how much we will save in the action plan
Review	•Monitor and review improvements of the project after installation •Review the operation for more improvements

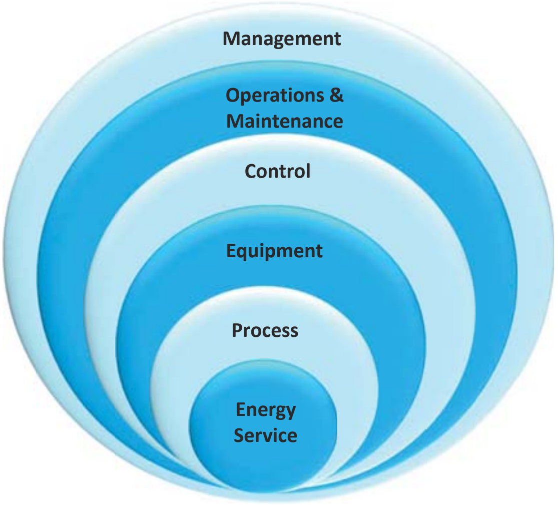
Agenda for Today

Day 2 – Technical focus	
08:30 – 10:00	Steam and Hot Water Boilers
10:00 – 10:30	Break
10:30 – 12:00	Air Compressors and Pumping
12:00 – 13:30	Lunch
13:30 – 15:00	Refrigeration and Lighting
15:00 – 15:30	Break
15:30 – 16:30	HVAC and Process Reviews

Day 2 Objectives

- Understand core SME energy-using technologies
- Learn where energy waste can occur and how to save it
- Gain skills to monitor performance with simple KPIs
- Learn about design, procurement, and O&M best practices
- Apply lessons through real-world case studies

Energy Venn Diagram



Layer	Definition	Ventilation Example
Management	The on-going management of energy performance of the system	EnPIs, Awareness campaigns, training on efficient operations
Operation & Maintenance	The on-going operation and maintenance of the equipment	Optimal operational control, consider manufacturer recommended maintenance
Control	The control applied to the equipment	Passive vents, Automation systems, switches
Equipment	The constituent parts of the process	Technology selected, vents, fans, dampers, ducting, fresh air vents, room vents.
Process	The means by which the energy service is delivered	Natural ventilation / Mechanical ventilation
Energy Service	The desired outcome that necessitates the consumption of energy	Fresh air requirements in the space, pressurisation, pressure profile, etc.

Agenda for Today

Day 2 – Technical focus	
08:30 – 10:00	Steam and Hot Water Boilers
10:00 – 10:30	Break
10:30 – 12:00	Air Compressors and Pumping
12:00 – 13:30	Lunch
13:30 – 15:00	Refrigeration and Lighting
15:00 – 15:30	Break
15:30 – 16:30	HVAC and Process Reviews

Boiler Basics: Boiler Types

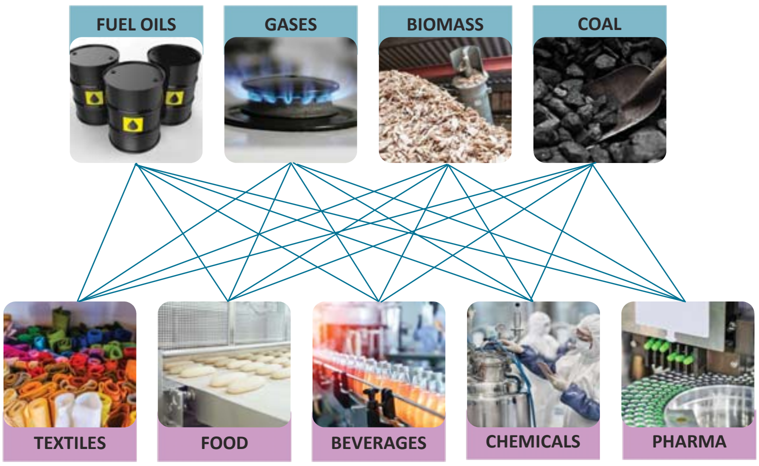
DOMESTIC TYPE HOT WATER BOILER

INDUSTRIAL TYPE HOT WATER BOILER

INDUSTRIAL TYPE GAS FIRED STEAM BOILER

INDUSTRIAL TYPE COAL FIRED STEAM BOILER

Boiler Basics: Boiler Fuels



- Several fuels available to companies depending on location.
- Efficiencies and cost reduction can be obtained through fuel switching.

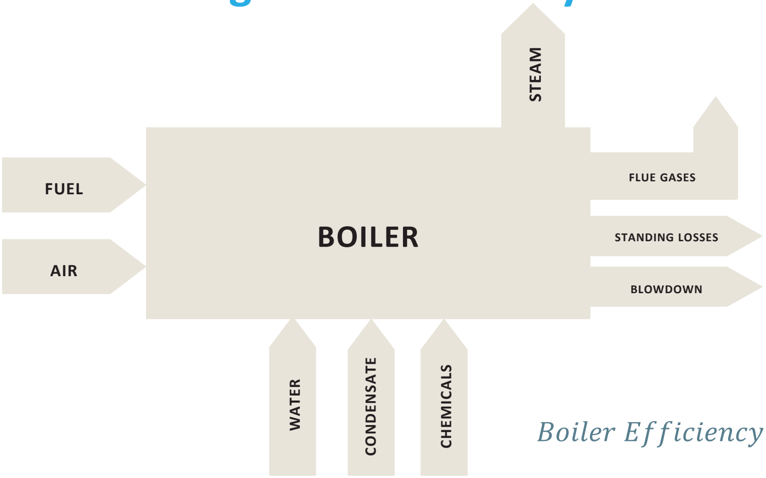
Boiler Basics: Steam

- Traditionally used as it allows for smaller pipework and does not require much pumping.
- When energy was cheap it was a cost effective means of heating many processes.
- More efficient to use hot water systems for lower temperature requirements <120°C.

Boiler Basics: Hot Water

- Potential to heat water up to ~120°C.
- Most hot water boilers heat water to <90°C for production and HVAC purposes.
- Hot water must be circulated around the site using pumps.

Calculating Boiler Efficiency



- Boiler efficiency is a measure of the energy consumed by the boiler i.e. the fuel, versus the energy generated by the boiler in steam or hot water.

$$Boiler\ Efficiency = \frac{Steam\ or\ Hot\ Water\ Output\ [kWh]}{Fuel\ Input\ [kWh]}$$

Calculating Boiler Efficiency

- A milk processing factory has two steam boilers that use natural gas as the fuel. They use 5,000,000kWh of gas annually and generate 4,000,000kWh of steam.

$$Boiler\ Efficiency = \frac{4{,}000{,}000kWh}{5{,}000{,}000kWh}$$

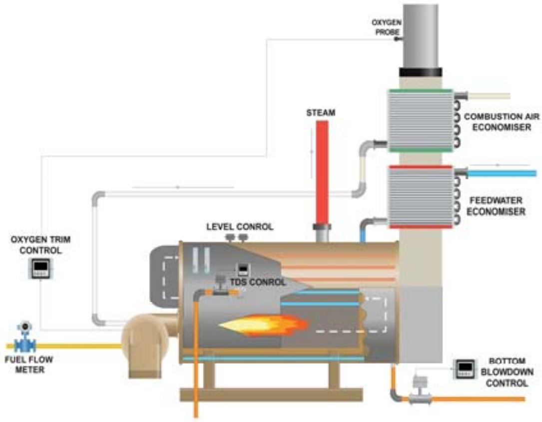
$$Boiler\ Efficiency = 80\%$$

Thermal Systems, Recognising the Opportunity

Common Inefficiencies in Boiler Systems

STEAM ONLY	LOW / High SOLIDS IN THE BOILER	LOW QUALITY FEEDWATER	LOW CONDENSATE RETURN RATE	STEAM TRAPS FAILING	
COMMON FOR BOTH	POOR INSULATION	POOR BURNER TUNING	TOO MANY BOILERS RUNNING	EXCESS COMBUSTION AIR	BOILER SCALING
HOT WATER ONLY	EXCESSIVE PUMPING	BOILERS NOT CONDENSING	HOT WATER HEADER MIXING	TEMPERATURE PROBE MALFUNCTION	

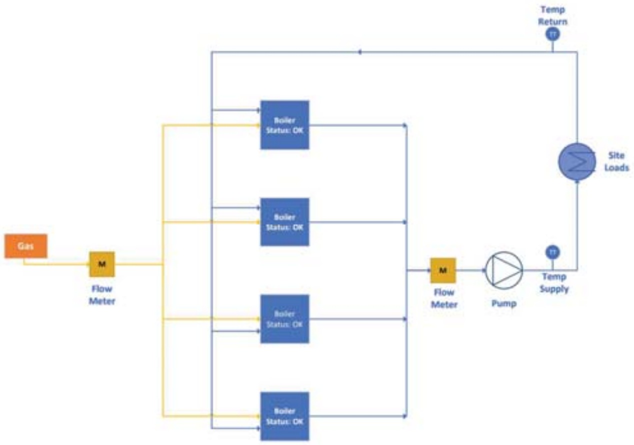
Boiler System Opportunities



- Optimal number of boilers.
- Flue gas heat recovery.
- TDS control.
- Blowdown heat recovery.
- Burner tuning & Oxygen trim.
- Boiler feedwater control.
- Boiler scale management.
- Improved condensate return rates.

Hot Water Boiler System Opportunities

- Optimal number of boilers.
- Flue gas heat recovery – ensuring the boiler condenses.
- Burner tuning & Oxygen trim.
- System top-up management.
- Boiler scale management.
- Distribution system flow control.



Boiler Operation & Maintenance

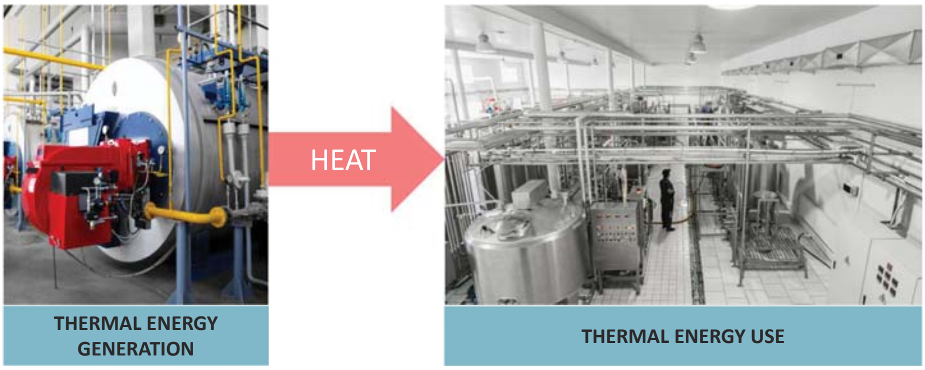
- It is important to have a maintenance plan and to carry out rounds and readings regularly.
- Maintenance processes should be put in place for daily, weekly, monthly, quarterly and annual, maintenance activities.
- This will ensure the safe and efficient operation of the boiler.
- The boiler should be taken out of service annually for a full internal and external inspection.
- Steam trap tests should be carried out at least annually.

Boiler Operation & Maintenance

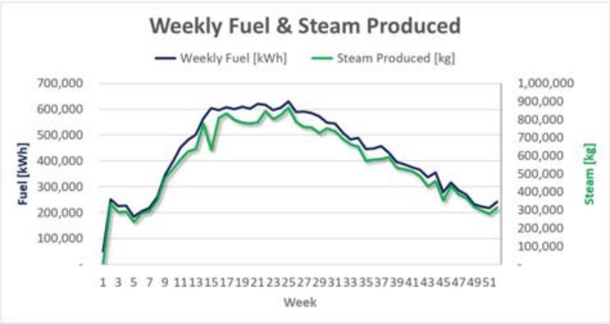
- Rounds and readings should include checks for:
  - Correct pressure and temperature readings.
  - Number of boilers running [heat demand versus heat potential]
  - Insulation damage.
  - Leaks.
  - Flue oxygen levels
  - Steam boiler solids.
  - Condensate return rate.
  - Feedwater quality.
  - Number of pumps running and pump VSD speeds.

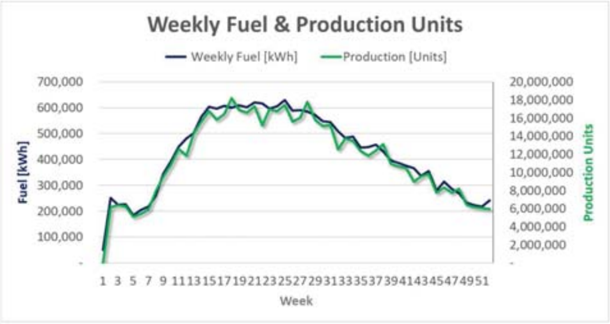
Boiler System Performance Monitoring

- Boilers should be monitored using Energy Performance Indicators [EnPIs].
- It is important to understand both the boiler efficiency and whether heat is being used efficiently.



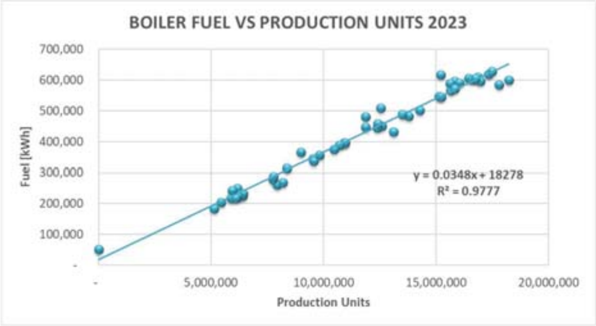
Determine Boiler System Energy Drivers

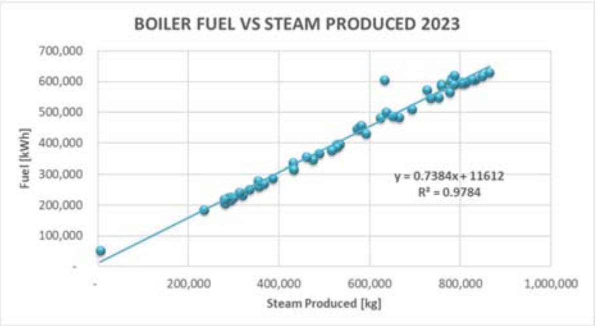




- Variables that drive fuel use should be analysed.
- This can allow for both the review of energy performance relative to site activity, and the review of equipment performance.
- **What questions does the analysis above raise?**

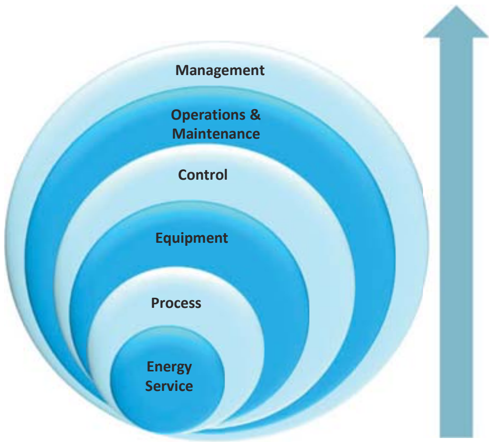
Review Energy Generation & Energy Use using regression





- We can use regression analysis to develop a baseline model for energy use in the boilers.
- We will look at how this analysis can be utilised for all big energy users later.

Boiler System Design



Layer	Definition	Boiler Example Questions
Management	The on-going management of energy performance of the system	• Does the design include measurement of fuel in and heat out and is data easily downloaded? • Can I see boiler efficiency on the boiler control screen?
Operation & Maintenance	The on-going operation and maintenance of the equipment	• What maintenance tasks need to be put in place to maintain efficiency? • Can the supplier recommend maintenance activities?
Control	The control applied to the equipment	• Can we install a VSD to optimise combustion air volumes? • Can we install VSDs and 3-element control on the feedwater pumps to minimise pumping? • Is there automatic TDS control on steam boilers?
Equipment	The constituent parts of the process	• What is the highest efficiency boiler that I can buy? • Can we use four smaller boilers to improve efficiency instead of using two large ones? • What are the most efficiency pumps that I can buy?
Process	The means by which the energy service is delivered	• Can I use hot water instead of steam? • Can I use recovered heat from the factory? • What about heat pumps?
Energy Service	The desired outcome that necessitates the consumption of energy	• Do I really need heat? • Do I need heat at that temperature?

Boiler Case Study

- GreenBakes Ltd., a small food factory, depends on hot water for production and cleaning. Its 12 year old gas boiler (500 kW) runs 18 hours daily but now operates at only 65–70% efficiency. Gas use has risen 15% in five years, costs are mounting, and downtime from scale and aging parts disrupts output.
- The company must choose between
  - refurbishing the boiler,
  - replacing it with a high-efficiency unit,
  - adopting a hybrid system with heat pump/solar
  - capturing waste heat from ovens and compressors.
- How would you suggest they approach this issue from an energy efficiency perspective?

It's Coffee Time

Agenda for Today

Day 2 – Technical focus	
08:30 – 10:00	Steam and Hot Water Boilers
10:00 – 10:30	Break
10:30 – 12:00	Air Compressors and Pumping
12:00 – 13:30	Lunch
13:30 – 15:00	Refrigeration and Lighting
15:00 – 15:30	Break
15:30 – 16:30	HVAC and Process Reviews

Air Compressors

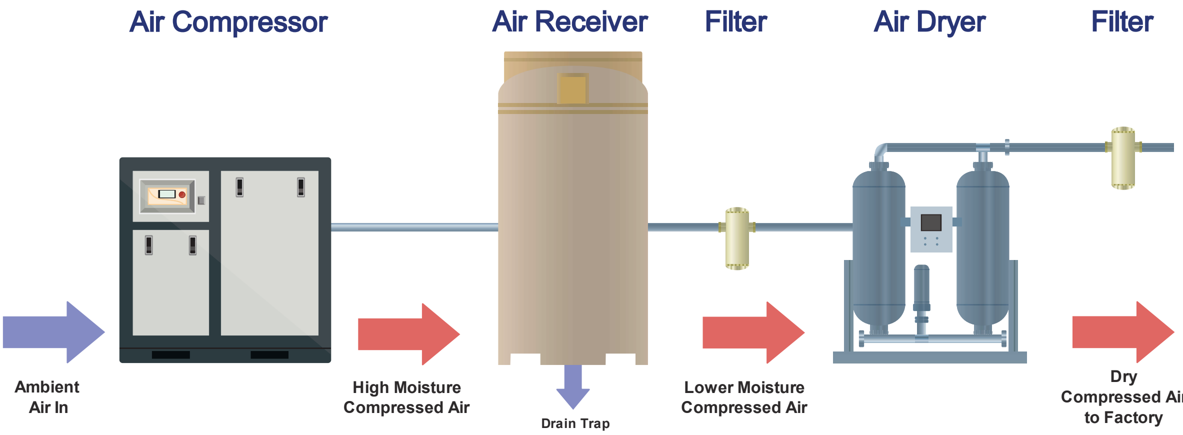
SMALL SCALE PISTON TYPE COMPRESSOR

LARGE SCALE SCREW TYPE COMPRESSOR

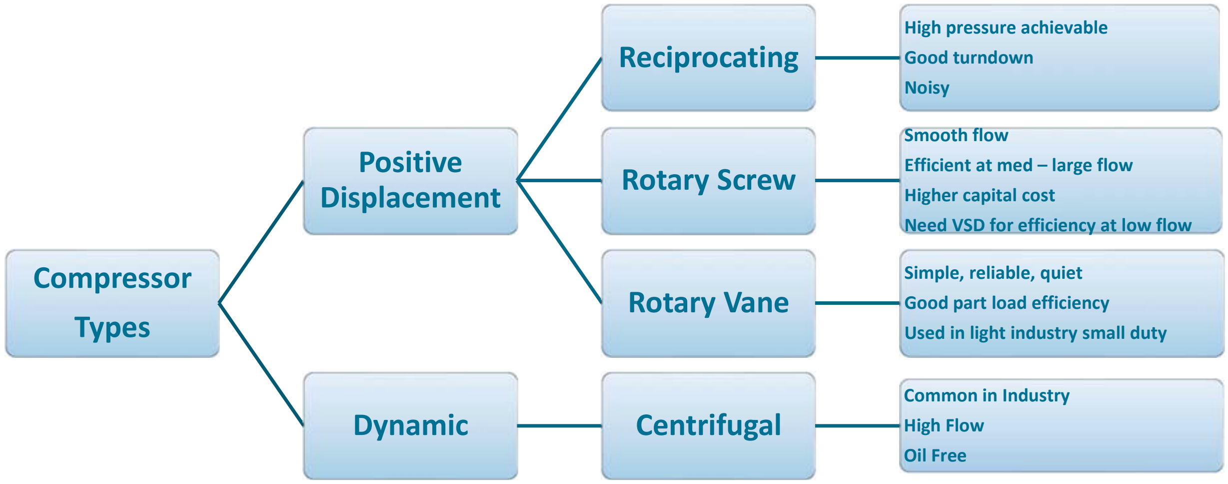
Source: Atlas Copco

MINISTRY OF INDUSTRY AND TRADE
Global Gateway
Funded by the European Union
UNIDO
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

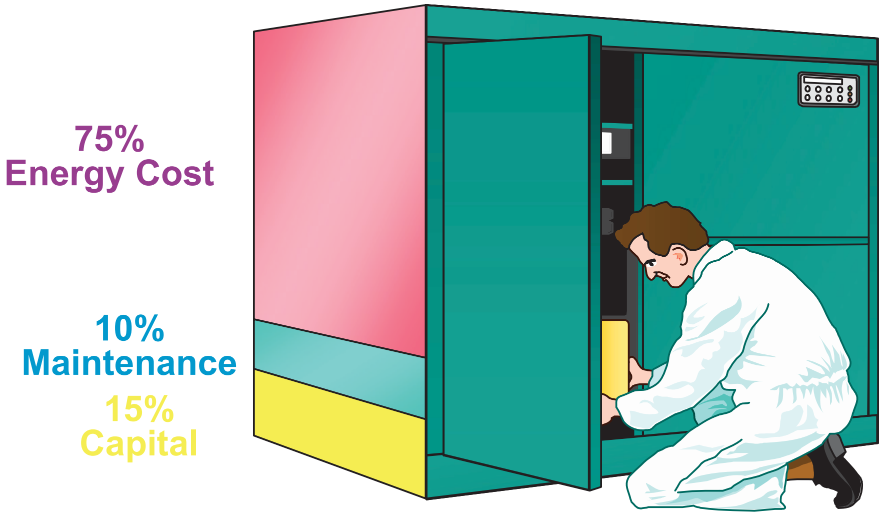
Compressor System



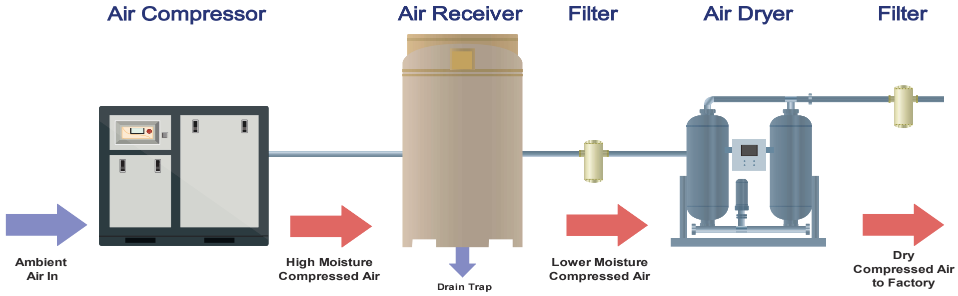
Types of Air Compressor



Life Cycle Cost of Air Compressor



Common Inefficiencies in Compressed Air Systems



Inlet air dusty/dirty	Too many compressors running	Air receiver in the wrong place	Dewpoint setting too low	Leaks
Inlet air hot & humid	Low motor efficiency & no VSD	Receiver too small	Purging with compressed air	Inappropriate use
	Wrong type compressor	Drain trap not functioning	Purging on time not dewpoint	No isolation
	Pressure setpoint too high	Drain trap not automatic	Incorrect dryer type	Excessive filtration

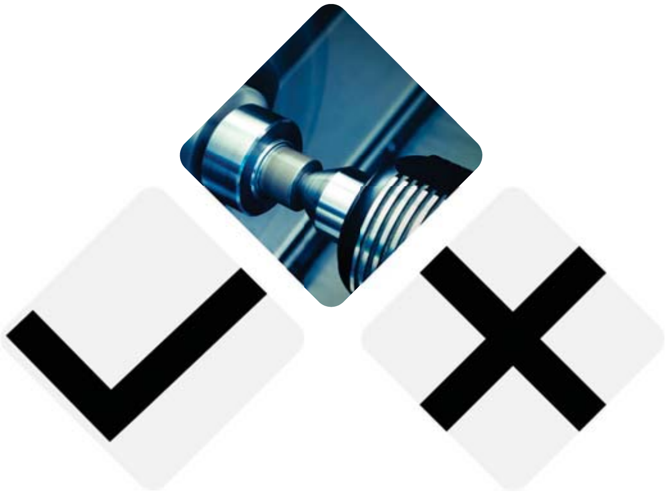
Compressed Air Uses

Appropriate Use

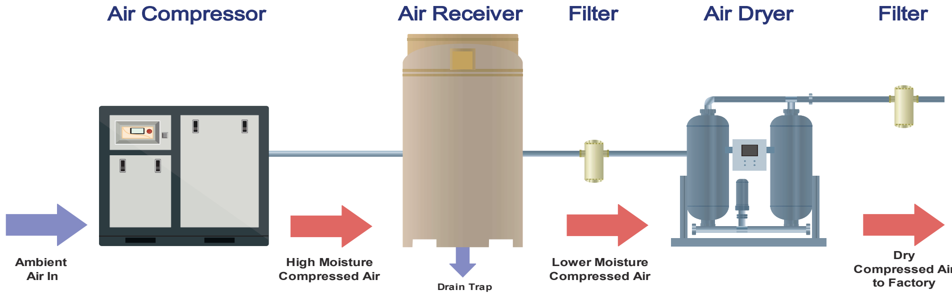
- Pneumatic Actuation
- Pneumatic Tools
- Packaging Machinery
- Instrumentation and Controls
- Pneumatic conveying
- Pumping
- Motors
- Aeration

Inappropriate Use

- Open blowing
- Sparging
- Aspirating
- Atomizing
- Padding
- Dilute phase transport
- Vacuum generation
- Personnel cooling
- Cabinet cooling



Compressed Air System Opportunities



Air Compressor
- Duct cooler air from outside
- Ensure inlet air filters are clean
- Install high efficiency motors & VSDs
- Recover heat
- Install a sequencer for >1 compressor
- Challenge pressure requirements

Air Receiver
- Ensure receiver is on wet side
- Correctly size the receiver.
- Install receivers at large users.
- Install a moisture sensing drain trap

Air Dryer
- Challenge dewpoint setpoint
- Use heated dryers
- Regenerate on dewpoint.
- Correctly size dryers.

Filter
- Implement a leak tagging system
- Carry out an inappropriate use review
- Ensure various lines & processes can be isolated
- Meter compressed air use

Compressed Air Rules of Thumb

- 80-93% of the electrical energy consumed by a compressor is converted into heat. The installation of a heat recovery unit can reclaim anywhere from 50- 90% of the available thermal energy
- Every 1 bar in pressure reduction produces a 6-7% power saving
- Improving the efficiency of a compressed air system should begin with a strategic assessment of the core energy services and work its way back to the generation station
- One 4mm hole in a compressed air distribution pipe operating throughout the year can cost €4,010 P.A. on a typical compressed air system operating at 8 bar (electricity at an average unit cost of €0.20/kWh)
- A 1% reduction in compressor power consumption can be achieved through a 4°C reduction in inlet temperature
- Air velocity in the distribution main should not exceed 6 m/s
- Air velocity in distribution branch lines should not exceed 15 m/s
- A 50% increase above the maximum proposed air velocities increases system energy use by approximately 2%
- For areas with different production times, the use of zone isolation valves should be considered
- If a top-up compressor is being called 30-70% of the time, the economic case for the installation of a VSD machine should be investigated

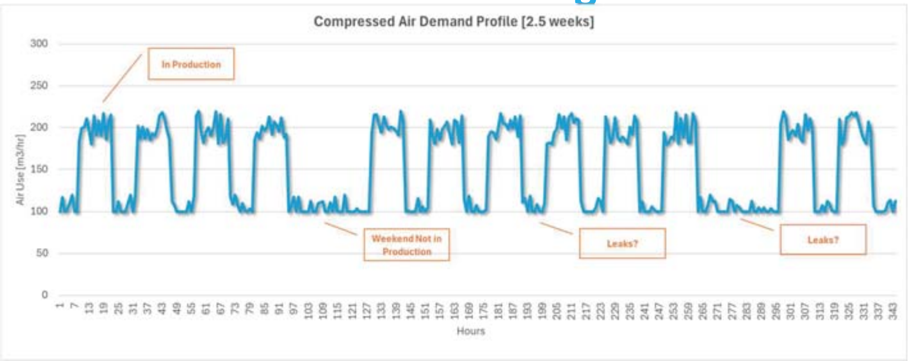
Source SEAI: Compressed Air Technical Guide

Compressed Air Operation & Maintenance

- It is important to have a maintenance plan and to carry out rounds and readings regularly.
- Maintenance processes should be put in place for daily, weekly, monthly, quarterly and annual maintenance activities.
- Rounds and readings should include the recording and checking of:
  - Pressures at the compressor and post drying.
  - Compressor temperatures and load/unload hours.
  - Air and oil leaks.
  - Filter and receiver blowdown operation.
  - Filter condition.
  - Dewpoint setpoint and value.
  - Compressor inlet filter condition.
  - Check the full distribution system at least twice annually for leaks.

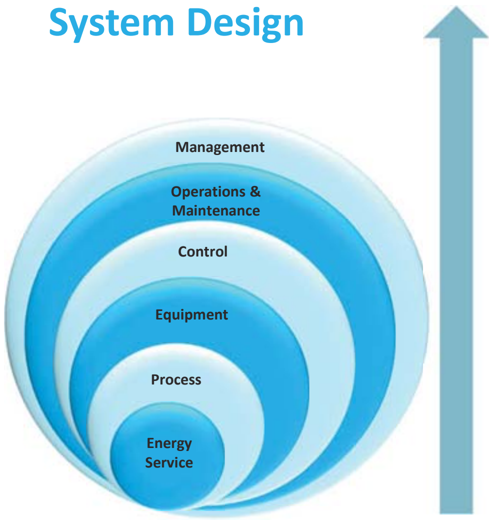
MINISTRY OF INDUSTRY AND TRADE
Global Gateway
Funded by the European Union
UNIDO
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Compressor Performance Monitoring



- Compressed air system electricity and air outlet flow should be measured.
- Factories using a lot of compressed air should also meter various process air demands.
- Regression analysis should be used also to develop metrics, similar to what we saw for boilers i.e. Electricity Vs Air Generated, Electricity Vs Production Output, Air Out Vs Production Output.

Compressed Air System Design



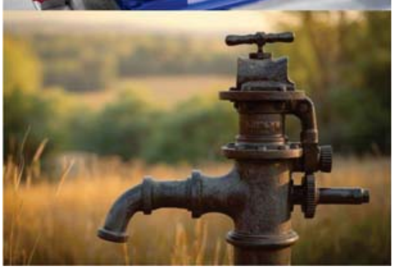
Layer	Definition	Compressed Air Example Questions
Management	The on-going management of energy performance of the system	• Does the design include measurement of electricity in and air produced and is data easily downloaded? • Has compressed air system training been added to the training requirements for internal personnel?
Operation & Maintenance	The on-going operation and maintenance of the equipment	• Can I lock down setpoints so that they can't be changed without authorisation? • Can we get an SOP in place for shutdowns, holidays, and out-of-hours isolation?
Control	The control applied to the equipment	• Can a VSD be installed to optimise compressor efficiency? • As we are installing three compressors what efficiency gain will a sequencer give us?
Equipment	The constituent parts of the process	• What is the best efficiency compressor to meet my minimum and maximum demands? • Will a larger receiver remove peak load the compressors? • Can waste heat be recovered to the boiler system?
Process	The means by which the energy service is delivered	• Can an impellor be used instead of compressed air for agitation? • Can a blower/fan be used instead of compress air for cooling?
Energy Service	The desired outcome that necessitates the consumption of energy	• Do I really need to agitate the tank? • Can I cool the product with ambient air not compressed air? • Why do I need this compressed air pressure? Can we reduce the pressure to a lower value?

Compressed Air Case Study

- BottleCo Ltd., a small packaging manufacturer, relies heavily on compressed air for PET blow moulding. The facility uses several high pressure compressors, but an energy audit shows significant inefficiencies. Leaks, poor pressure control, and oversized compressors mean only around 10% of input electricity is effectively used. Compressed air now accounts for nearly 40% of total electricity costs. Compressed air issues also lead to frequent breakdowns and inconsistent bottle quality.

- What steps would you take to reduce energy waste and improve production reliability?

Pumping

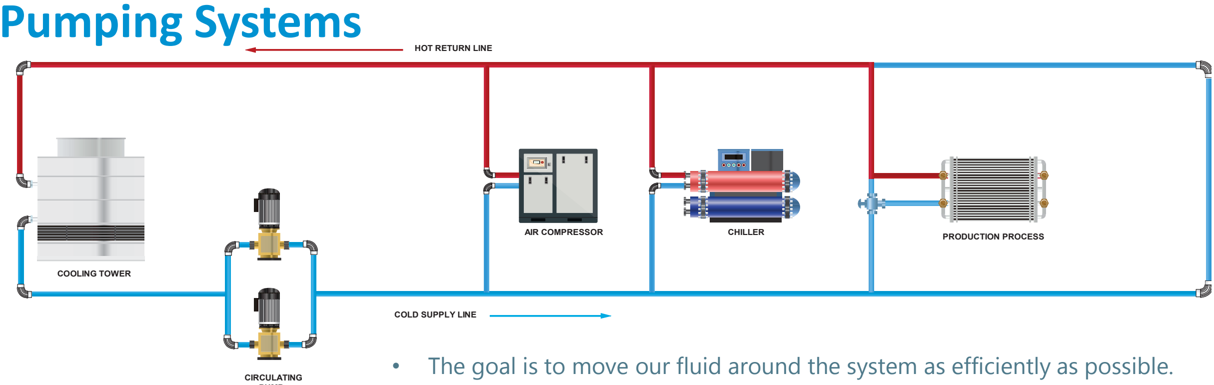


- Wide range of pump types available.
- Most common type of pump is centrifugal.

Source: Pump Engineering

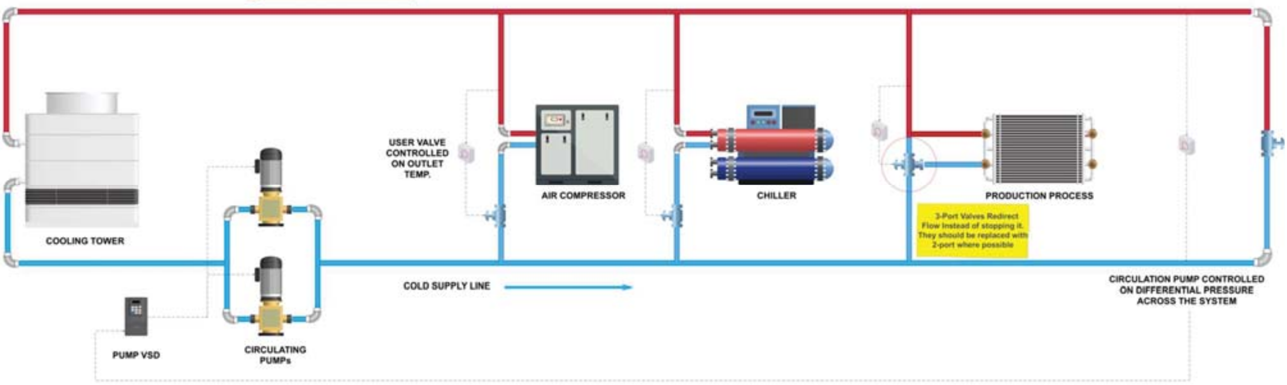
MINISTRY OF INDUSTRY AND TRADE
Global Gateway
Funded by the European Union
UNIDO UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Pumping Systems



- The goal is to move our fluid around the system as efficiently as possible.
- Pumping systems with no control will just pass fluid at a continuous rate around the system.
- We want to maximise efficiency by reducing pressure drop, limiting flow, and delivering the right amount of fluid to the right place at the right temperature at all times.

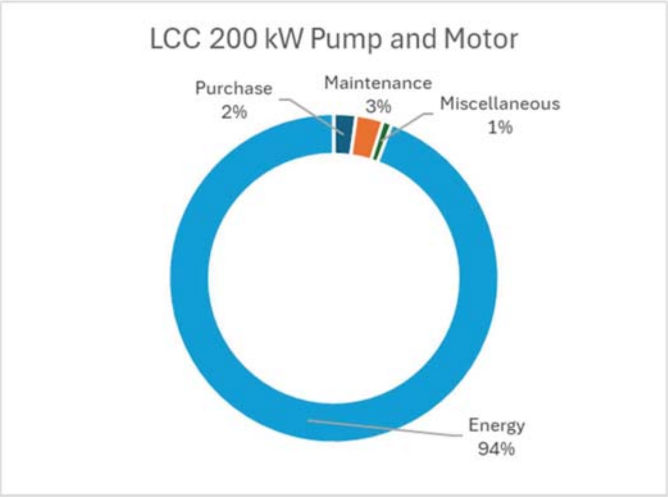
Pumping Systems



- Control valves at users and at the end of distribution lines can ensure optimal fluid delivery.
- Controlling pumps on pressure in the system via a VSD will reduce energy demand.

Pumping Lifecycle Cost

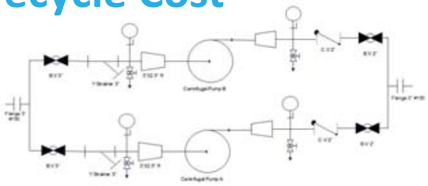
- The purchase price is very low compared to the operational cost.
- A 10kW pump running all year can cost ~ $328,500 to run over 15 years.
- This pump costs ~ $11,000 to purchase and install.

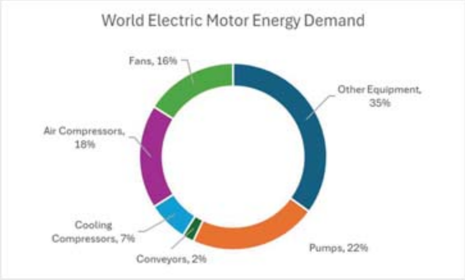


Discussion on Pumping System Lifecycle Cost

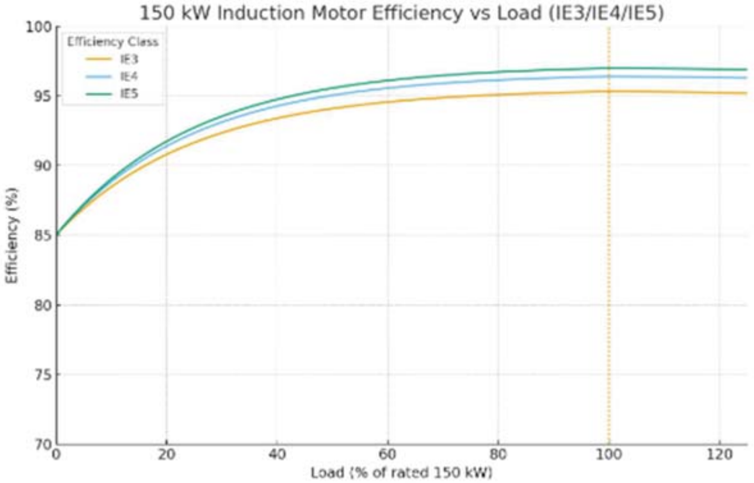
For Lifecycle cost consider the following:

- purchase costs
- installation & commissioning costs
- Energy costs
- Other operating costs
- Maintenance costs
- Down time costs
- Decommissioning costs
- Environmental costs





Efficiency chart for a high efficiency motor



- Take our example from before: 10kW pump operating 8,760 hours per year with pump cost of $11,000.
- A 2% efficiency gain = 1,732kWh or $438 saved per year.
- It is important to determine the benefit of upgraded efficiency based on additional cost, run hours, efficiency gain, energy unit price.

Pump Affinity Laws

- Power consumption is directly impacted by flow in the system.
- If we reduce flow to 90% of its original rate, we reduce the power draw to **(0.9*0.9*0.9) = 73%** of its original draw.
- This is common for all other fluid/air/gas moving systems.

$$\left(\frac{Q_1}{Q_2}\right) = \left(\frac{N_1}{N_2}\right)^1$$

$$\left(\frac{H_1}{H_2}\right) = \left(\frac{N_1}{N_2}\right)^2$$

$$\left(\frac{P_1}{P_2}\right) = \left(\frac{N_1}{N_2}\right)^3$$

Q = Flow Rate P = Power
H = Head N = Speed

Rotation Speed	Flow	Power Capacity
100%	100%	100%
90%	90%	73%
80%	80%	50%
70%	70%	34%
60%	60%	22%
50%	50%	13%
40%	40%	6%
30%	30%	3%

Source: PECSME, Promoting Energy Conservation in Small and Medium(-scale) Enterprises (2006-2011)

Pumps system Formula

We should challenge this

We should design this out where we can.

We may not be able to impact this as it could be product specific

$$Fluid\ Power = \frac{Flow\ rate * Head * Density}{102}$$

$$Fluid\ Energy = Fluid\ Power * Operating\ Time$$

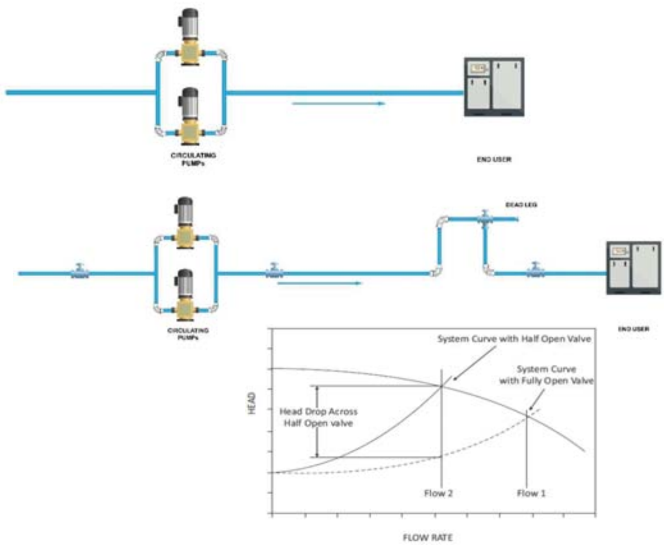
Key to pumping systems is to understand these formula when assessing pumps, so the key items to keep in mind are:

1. Volume Required
2. Head (including friction losses)
3. Operating time required

Friction Losses

What causes friction losses in the system?

- Valves
- Elbows
- Tees
- Reducers
- Expansion joints
- Tank inlets



System with lower friction losses

System with higher friction losses

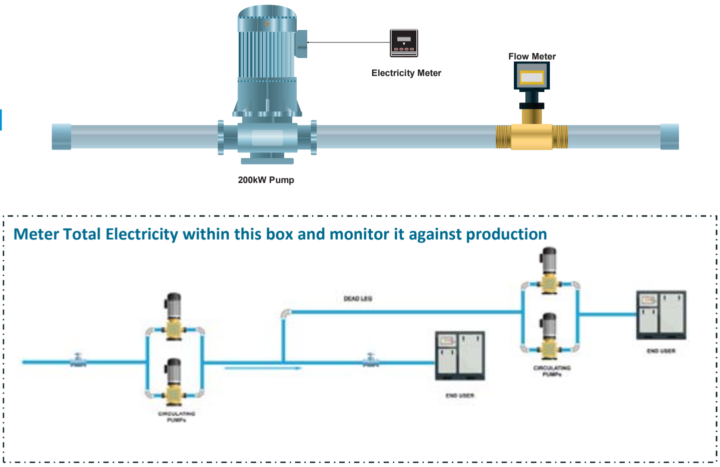
Typical Pumping Systems where Opportunities Exist

- Systems where significant throttling takes place
- Systems with recirculation of flow used for control
- Systems with large flow or pressure variations
- Multiple pumping systems where the number of operated pumps is not adjusted in response to changing conditions
- Systems serving multiple end uses where a minor user sets the pressure requirements.
- Cavitating pumps and/or valves
- High vibration and/or noisy pumps, motors or piping
- Pumps with high maintenance requirements
- Systems where the functional requirements have changed with time, but the pumps have not.
- Motor issues: Oversizing, reduced efficiency due to rewinding etc.

MINISTRY OF INDUSTRY AND TRADE · Global Gateway · Funded by the European Union · UNIDO UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Pump & Motor System Performance Monitoring

- Pumps and motors can be spread widely throughout a facility.
- Very large motors or pumps should be metered individually.
- Larger groups of pumps should be metered and energy demand monitored against known energy drivers where possible.

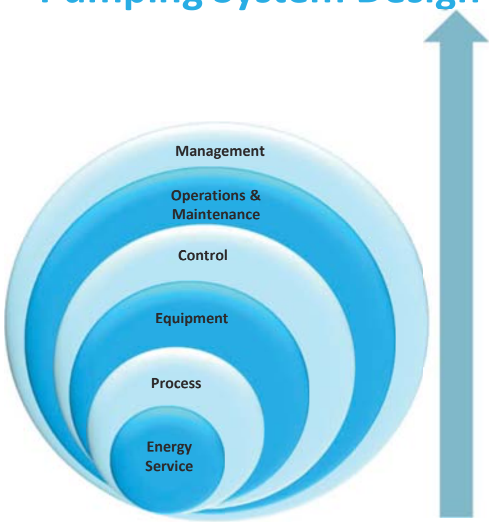


MINISTRY OF INDUSTRY AND TRADE · Global Gateway · Funded by the European Union · UNIDO UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Pump & Motor Operation & Maintenance

- It is important to have a maintenance plan and to carry out rounds and readings regularly.
- Rounds and readings should include the recording and checking of:
  - Greasing to the correct level.
  - Review of excessive vibration
  - Review of excessive noise e.g. cavitation.
  - Checking for pipe/duct leaks.
  - Clean strainers/filters.
  - Ensuring correct alignment on installation and after maintenance.

Pumping System Design



Layer	Definition	Pumping System Example Questions
Management	The on-going management of energy performance of the system	• Can differential pressure alarms be put in place? • Have electricity and flow meters been put in strategic positions to allow for system monitoring?
Operation & Maintenance	The on-going operation and maintenance of the equipment	• Can we install heat exchanger cleaning points to reduce fouling which would increase flow requirements? • Can vibration analysis be installed on all larger motors?
Control	The control applied to the equipment	• Can we dynamically balance the system using pressure independent control valves? • Can we control the pumps on system differential pressure?
Equipment	The constituent parts of the process	• Can we set a requirement for minimum motor efficiency rating of IE4? • Is the pump type matched to duty and operating near best efficiency point [BEP]? Show me please.
Process	The means by which the energy service is delivered	• Can we use pumped storage rather than continuous pumping? • Can we relocate equipment to reduce pipe runs?
Energy Service	The desired outcome that necessitates the consumption of energy	• Can we use gravity fed systems instead of pumping? • Is it possible to reduce the flow rate and head pressure in the system? • Is recirculation necessary?

Pump & Motor System Case Study

- FlowTech Ltd., a small specialty chemicals plant, circulates cooling water through a 45kW pump. The pump runs at constant speed, with a control valve ~60% closed to throttle flow. An energy audit shows the pump operating far from its best efficiency point, with throttling losses, recirculation at low demand, and night/weekend running despite minimal load. This is resulting in rising electricity use, hot return water increasing chiller load, and frequent seal/bearing failures.

- What action could the team take to reduce energy demand and make the system more reliable?

See you in 45 minutes!

Agenda for Today

Day 2 – Technical focus	
08:30 – 10:00	Steam and Hot Water Boilers
10:00 – 10:30	Break
10:30 – 12:00	Air Compressors & Pumping
12:00 – 13:30	Lunch
13:30 – 15:00	Refrigeration and Lighting
15:00 – 15:30	Break
15:30 – 16:30	HVAC and Process Reviews

Refrigeration Systems

AIR COOLED CHILLER

WATER COOLED CHILLERS

VARIABLE REFRIGERANT VOLUME

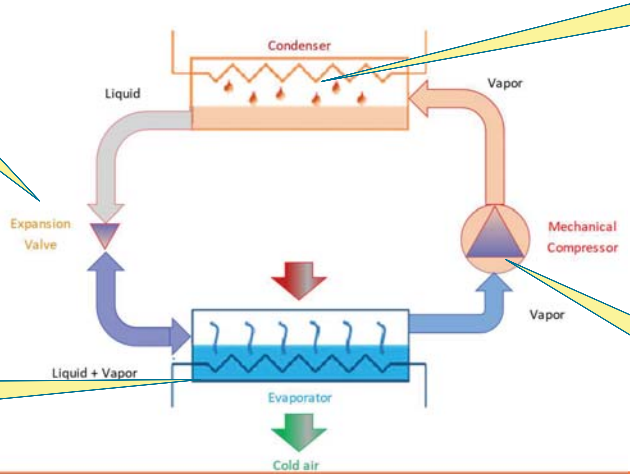
Basic Refrigeration Schematic

Pressure Reduction, temperature of the refrigerant reduces

Condenser

water-cooled or air-cooled

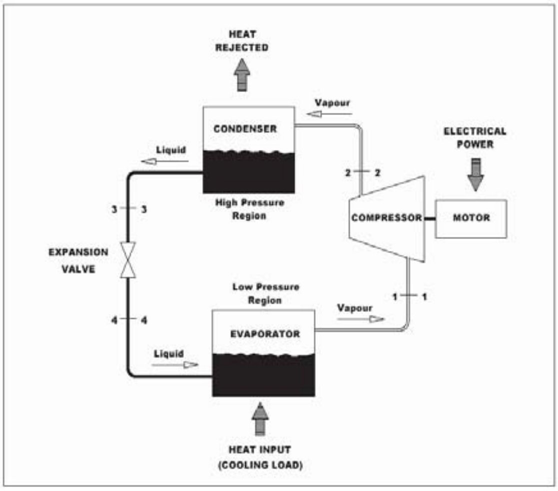
The heat is dissipated and the refrigerant turns back to liquid

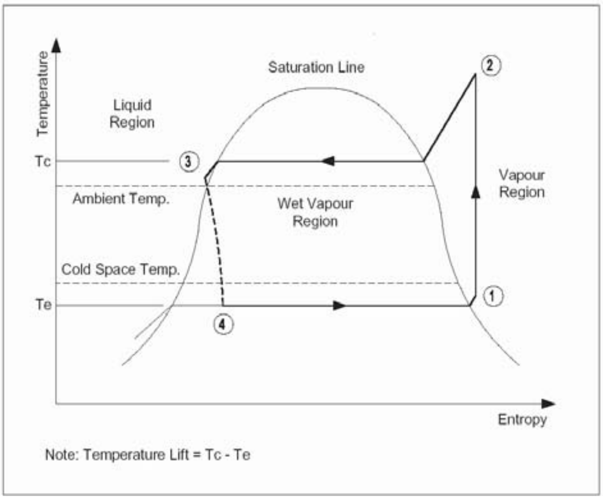


The refrigerant absorbs heat and becomes vapour

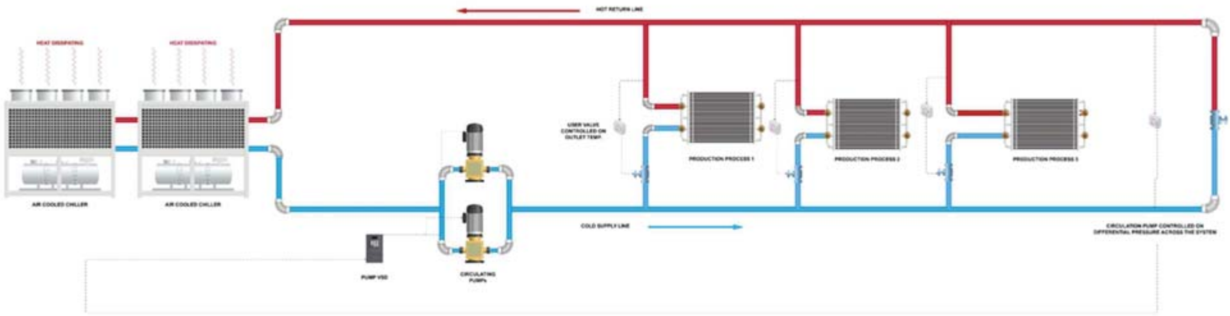
The refrigerant vapour is raised to a higher pressure

Temperature – Entropy Diagram



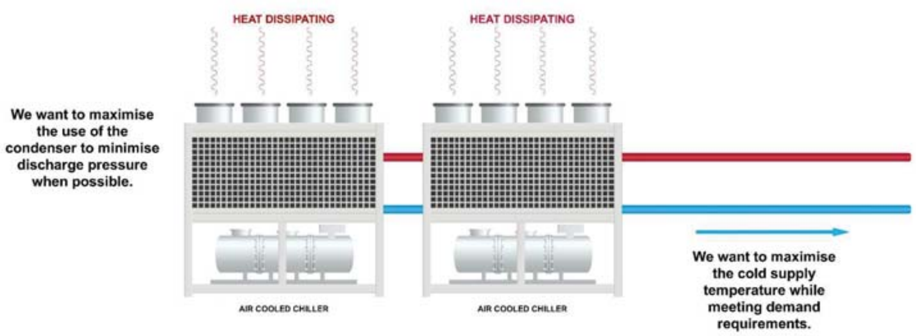


Basic Refrigeration System



- Similar to our boiler and pumping examples we want to deliver the right temperature and flow to the right place at all times as efficiently as possible.
- We need to know the temperature and flow requirements of our users to optimise the system.
- The higher the temperature that we can deliver to the system from the chillers, the better the efficiency.

Basic Refrigeration System



- Maximising the work done by the condenser [fans and fins], reduces the amount of work needed in the compressor.
- Increasing the temperature of the supply chilled water allows us to increase the pressure setpoint in the evaporator.

Refrigeration Plant Performance

$$COP = \frac{Cooling\ Achieved}{Power\ Consumed}$$

- Cooling & Power must be expressed in the same units.
- COP is not expressed as a percentage, and it is not usually less than 1.
- For most industrial applications the COP can be expected to range between about 2 and 5 depending upon the operating temperatures and temperature lift.
- The temperature lift is defined as the difference between the condensing temperature and the evaporation temperature.
- Minimising temperature lift should be a key focus of the audit.
- The higher the COP the better the plant performance.

MINISTRY OF INDUSTRY AND TRADE · Global Gateway · Funded by the European Union · UNIDO UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Refrigeration System Opportunities

What items should we look for in determining opportunities for improvement in refrigeration..........

- Keep evaporator and condenser coils clean.
- Increase evaporation pressure.
- Decrease condensing pressure.
- Optimise defrost cycles.
- Control fan operation.
- Minimise pumping.
- Enhance Insulation.
- Control cold room door operation.
- Prevent ice build-up.
- Find and control parasitic loads
- etc.

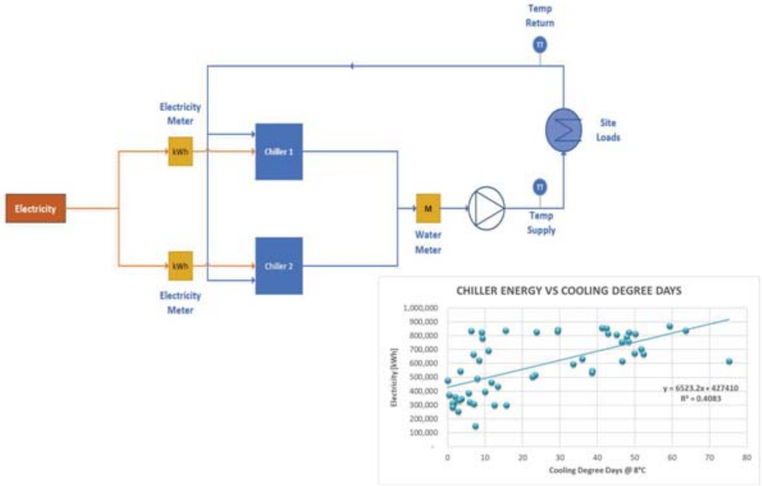
What opportunities for improvement are in your refrigeration plant?

MINISTRY OF INDUSTRY AND TRADE · Global Gateway · Funded by the European Union · UNIDO UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Cold Store Operations

- Cold store doors can represent a significant load on cold and chill store refrigeration plant.
  - The doors should be closed whenever possible. Whatever system is installed to close doors, it must be operated effectively, so that air ingress is minimised.
- Lighting in cold and chill stores and air-conditioned spaces is cooling load.
  - Lighting loads should be reduced by switching off whenever possible, or by ensuring control systems are set up to keep lights off for as long as possible.
- Do not obstruct evaporator airflow.
  - For instance by products
- Minimise heat sources in the cold store
  - Lights, fork-lift truck, etc.
- Report ice on the floor and walls of the store
  - Indicates moisture laden air is entering the room.
- Do not keep the room colder than necessary.
- This may require good management controls and changes to operating practices.

Refrigeration System Performance Monitoring System



- Sufficient metering is required to monitor refrigeration system performance.
- Electricity meters required on chillers.
- Thermal meters required on thermal output.
- Chiller performance i.e. energy in versus energy out should be monitored.
- The use of chiller energy should also be monitored i.e. Chiller energy use versus site activity or weather data.

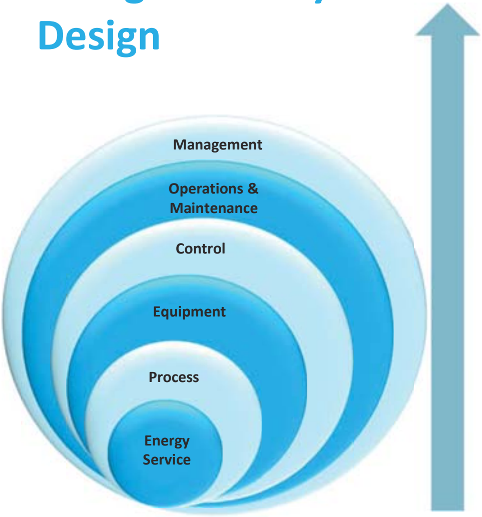
Refrigeration Plant Top 10 Opportunities

Chiller Sequence Control (run the optimum number of chillers to match the cooling load profile)	Delta T monitoring on the Chilled Water system to ensure design Delta T is achieved and pumping minimised.	Minimise Temperature lift (Distribution Temperature increase and Condenser temperature reduction)	Setback temperature setpoints on chilled water system based on cooling demands.	VSD on chilled water distribution system.
End of line valves isolated or minimised and two-way valves on end users and all end users have temperature control.	All pipework insulated effectively.	Ensure there are no psychrometric (HVAC) loads on the process chiller and visa versa.	Chiller review of control valves in conjunction with heating systems (loop tuning)	Review the heating and cooling valves to identify rapid cycling between the heating and cooling systems.

Refrigeration System Operation & Maintenance

- It is important to have a maintenance plan and to carry out rounds and readings regularly.
- Rounds and readings should include the recording and checking of:
  - Suction and discharge pressures to ensure that they are aligned with required values.
  - Number of compressors running.
  - Condenser operation to ensure that dissipation is being maximised.
  - Number of pumps running.
  - System Coefficient of Performance [COP]
  - Evaporators and condensers for excessive fouling.
  - Ice build-up
  - Leaks and insulation integrity.
  - Any system pressure alarms which may indicated refrigerant leakage.

Refrigeration System Design



Layer	Definition	Refrigeration Example Questions
Management	The on-going management of energy performance of the system	• Have energy meters been placed on the system electricity demand and thermal energy output? • Have alarms been setup to notify us of system issues?
Operation & Maintenance	The on-going operation and maintenance of the equipment	• Have rounds and readings required to operate and maintain the system been documented. • Can we install heat exchanger cleaning points to reduce fouling which would reduce heat transfer efficiency?
Control	The control applied to the equipment	• Has floating head pressure control been implemented? • Have sufficient valves and controls been put in place on the distribution system to prevent excessive flows. • How do we ensure that the primary loop flowrate remains higher than the secondary loop flowrate?
Equipment	The constituent parts of the process	• Can we use a water-cooled system to improve system efficiency? • Can we use magnetic bearing chillers to reduce motor friction? • Have VSD driven compressors been specified?
Process	The means by which the energy service is delivered	• Can we recover heat from refrigeration systems rather than dump it to atmosphere? • Can we use night purge office spaces to reduce daytime loads? • Can we use ice banks to store cheap energy at night?
Energy Service	The desired outcome that necessitates the consumption of energy	• Can we increase chilled water/refrigeration setpoints? • Can we eliminate any heat loads from the system? • Can we eliminate the need to refrigerate by moving product direct to customers faster?

Refrigeration System Case Study

ChillChain Ltd., a small food distributor, runs two chill rooms at +2 °C. An audit shows compressors working harder than needed with low suction and high discharge pressures creating excessive lift in the system. Energy use is up 18% year-on-year. It was outlined that defrost times need to be excessive to prevent ice buildup, and there is an occasional temperature excursion which impacts quality.

What checks should the site do to determine where issues can be fixed savings can be achieved?

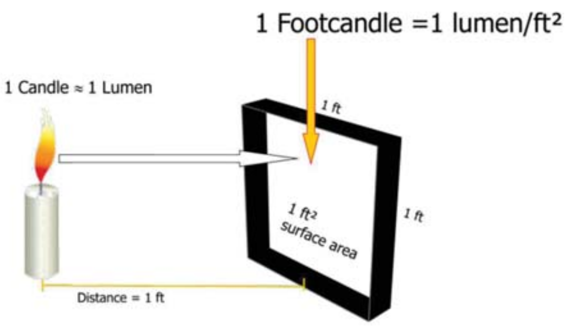
Lighting Basics

- Lighting can be a significant energy waste in Vietnam
  - Commercial SMEs (office, retail, hospitality) can use 17% of electricity
  - Manufacturing can use 6% of total electricity

Do you know how much lighting contributes to the energy balance in your organisation?

Lighting Units

- Three measures of lighting
- **Watts** (electrical input to the lighting device)
- **Lumens** (output of the lamp)
  Standard office flourescent tube 2900 lumens
- **Foot-candles** (amount of light actually reaching workplane)



Lighting Types

- Incandescent
- CFL
- Linear Fluorescent
- Mercury vapour
- Metal halide
- High Pressure Sodium
- Low Pressure Sodium
- Induction
- LED



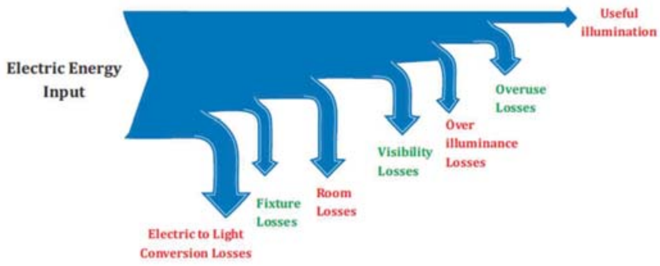



Table 9 2: Comparison of different light sources (source: *SLL Lighting Handbook*[1])

Type of source	Output range / lumen	Power range / W	Efficacy / lumen·W^{-1}	Life
Fluorescent:				
— T12	10 000–10 500	25–140	50–80	8000–12 000
— T8	650–6200	13–70	50–96	8000–17 000
— T5	120–8850	6–120	20–93	8000–19 000
Compact (CLF):				
— non-integral control gear	250–9000	8–120	30–70	Up to 15 000
— integral control gear	100–1500	5–30	20–50	5000–15 000
High pressure mercury:				
— MBF/HPL	2000–58 500	60–1040	33–57	8000–10 000
Metal halide:				
— quartz tube	5200–200 000	85–2050	60–98	2000–7000
— ceramic tube	1600–26 000	20–250	65–97	6000–10 000
Low pressure sodium:				
— SOX, SOX-E	1800–32 000	26–200	70–180	15 000–20 000
High pressure sodium:				
— standard SON	4300–130 000	85–1040	53–142	10 000–20 000
— delux SON	12 500–37 000	165–430	75–86	10 000–14 000
— white SON	1800–5000	45–115	40–44	6000–9000
Induction	2600–12 000	55–165	47–80	60 000 +
LEDS	20–220	1–5	30–100	15 000–60 000

Lighting Losses

- Electricity to lighting conversion loss
  - Light output/unit of input power [Lumes/Watt]
- Fixture Losses
  - Losses in the lamp
- Room Losses
  - (before it reaches task e.g. shading)
- Visibility Losses
  - Excess light supplied
- Over Illumination Losses
  - Excess provided to overcome poor distribution,
- Overuse Losses



Recommended Lux Levels

Source: Encyclopedia of occupational health and safety

Car Park	15 – 20 lux
Access Corridors	100 – 200 lux
Manufacturing areas	100 – 300 lux
Office Areas	300 – 500 lux
Visual Inspection	1000 – 1200 lux

Typical Lighting Opportunities

Understand the Lighting requirements for the space	Smart Controls such as motion sensors and photocells	Space planning to minimise space used after hours	Install multiple circuits to facilitate smart switching during low occupancy periods
Delamping areas to reduce excess lighting	Use Task Lighting	Turn off lights when not required	Open blinds and remove furniture from windows
Clean the luminaires	Install switching in convenient places	Lighting maps and education awareness training	Area maintenance, painting rooms, clean workspaces etc.

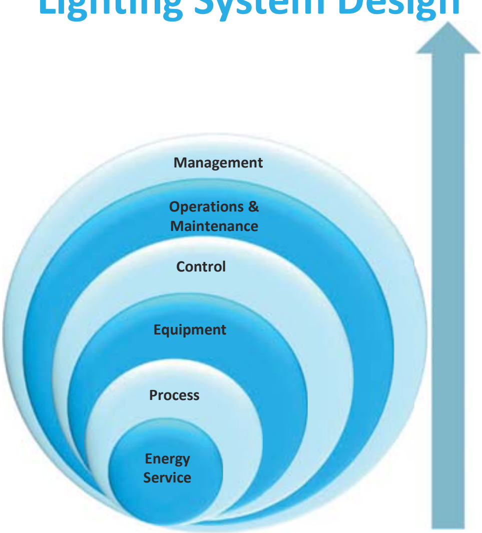
Lighting System Performance Monitoring

- Lighting can be difficult to monitor as lighting circuits can be spread widely throughout a facility.
- New buildings where lighting is a big energy user should consider metering lighting circuits effectively.
- Where it is not possible to monitor lighting on its own, energy meters at a building/distribution board level are appropriate.
- A lighting survey should be carried out annually to determine:
  - Lighting on when not required.
  - Review timers.
  - Ensure PIR and lux sensors are operating.
  - Determine lights needing replacement/upgrading.

Lighting System Operation & Maintenance

- Lighting should be surveyed regularly to ensure that it is operating efficiently if it is a big energy user. It would be useful to carry this survey out both during operating hours and outside normal operating hours. This survey should include:
  - Identification of any lights that are on when not required e.g. external day burners, lighting on in areas not visited frequently.
  - Determine any areas with light levels that are too high/low – use a lux meter.
  - Ensure that lighting controls are still working.
  - Ensure instructions on how lighting should be operated are available for personnel e.g. local signage.
  - Determining any areas where daylight is not being maximised.

Lighting System Design



Layer	Definition	Lighting Example Questions
Management	The on-going management of energy performance of the system	• Is there training/awareness planned for staff (task lights, blinds, manual overrides)? • Are procurement specs set future replacements (min lm/W, warranty, L90 target)?
Operation & Maintenance	The on-going operation and maintenance of the equipment	• Are cleaning intervals for lenses/reflectors defined? • Is there a simple user guide so occupants can understand the controls?
Control	The control applied to the equipment	• Have various lighting circuits and controls been setup based on the various space uses? • Are PIRs and Lux controls included where appropriate? • Are timers setup based on each functional zones requirements?
Equipment	The constituent parts of the process	• Are proposed luminaires high efficacy (lm/W) with proven lifetime (e.g., L90/B10)? • Are drivers efficient [Not Constant Light Output], dimmable?
Process	The means by which the energy service is delivered	• Can we rearrange tasks/workstations closer to daylight or lighter surfaces? • Can we use lower room light levels with specific task lighting for detailed work?
Energy Service	The desired outcome that necessitates the consumption of energy	• Can we reduce the lux levels in the space and ensure that they are in line with industry standards. • Can we use natural light? • How do we prevent excess sunshine resulting in people using blinds to block out light?

Lighting Exercise

A production hall has 500 fittings with 400w metal halide lamps installed.

- What is the potential energy savings resulting from replacing these fittings with 150W fittings?
- Assumption: 3,120 (12*5*52) operating hours and 12c/kWh

A. What is the energy saving for the project in kWh/yr.

B. What is the simple payback of the project if the investment cost is €330,000

C. The facility changes production activity and manufacturing is now 6240 (24*5*52) hrs/yr. What is the new saving?

Agenda for Today

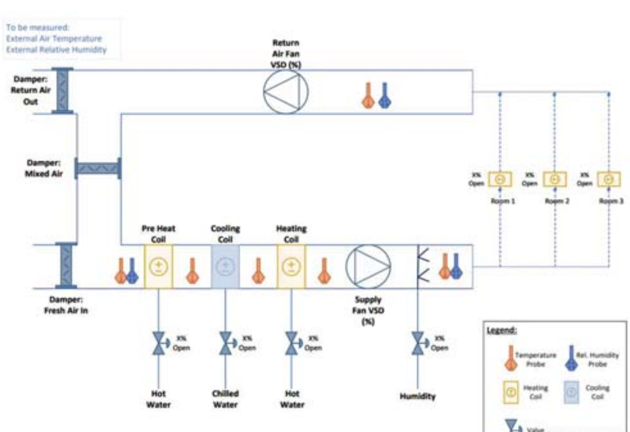
Day 2 – Technical focus	
08:30 – 10:00	Steam and Hot Water Boilers
10:00 – 10:30	Break
10:30 – 12:00	Air Compressors and Pumping
12:00 – 13:30	Lunch
13:30 – 15:00	Refrigeration and Lighting
15:00 – 15:30	Break
15:30 – 16:30	HVAC and Process Reviews

HVAC Basics

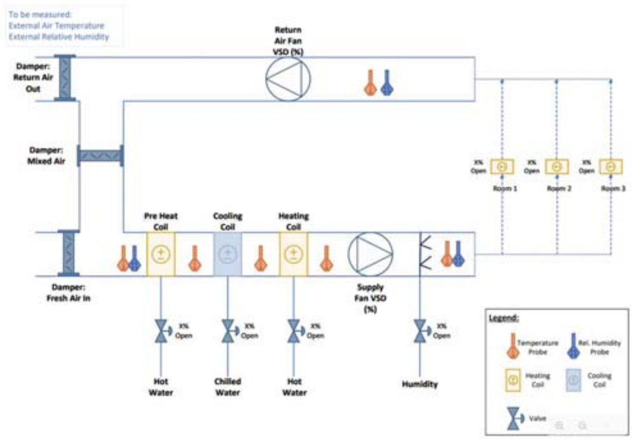
- HVAC systems include a wide array of equipment such as air handling systems and their associated heating, cooling and humidity control equipment.
- Requirements for air treatment will vary greatly depending on:
  - Geographical location.
  - Quality control requirements.
  - Space function.
  - Nationality of workers.
- Systems can be highly complex with a lot of moving parts that need regular maintenance.

MINISTRY OF INDUSTRY AND TRADE
Global Gateway
Funded by the European Union
UNIDO
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Air Handling Unit Example Layout



Inefficiencies in HVAC Systems



- Temperature & humidity probes not present or calibrated.
- Core focus on delivering space conditions rather than delivering space conditions efficiently.
- Passing heating or cooling coils resulting in coils compensating for each other.
- Zone setpoints much tighter than required.
- Dampers stuck or fixed resulting in an inability to maximise free cooling or humidity control.
- Poor understanding of HVAC strategies and design intent.

Inefficiencies in HVAC

Use of belt driver fans with no VSD controls results in fans running at full load.

Use of 3-port valves on heating & cooling coils increases pump demand.

Short cycling of exhaust air into inlet air, increasing heating/cooling loads.

Inefficiencies in HVAC

Poor insulation on heating and cooling pipework and AHU ducts.

Decentralising plant resulting in part load inefficiencies.

Dirty coils or filters increasing pressure drop in the system.

HVAC Opportunities

Widen the control requirement on space setpoints for temperature and humidity.	Add demand controls for spaces based on occupancy, CO_2.	Turn air handling systems off when not required.	Install multiple circuits to facilitate smart switching during low occupancy periods
Replace centrifugal fans with VSD driven EC fans and minimise flowrates	Maximise heat recovery and free cooling through damper controls	Track and eliminate simultaneous heating and cooling scenarios	Implement seasonal strategies [Summer/Winter] [Rainy/Dry]
Keep filters and coils clean and in good condition	Ensure coils have 2-port valves where possible	Repair any leaks in AHUs and ducts and repair/add insulation	Utilise heatpumps to provide heating and cooling

HVAC Performance Monitoring

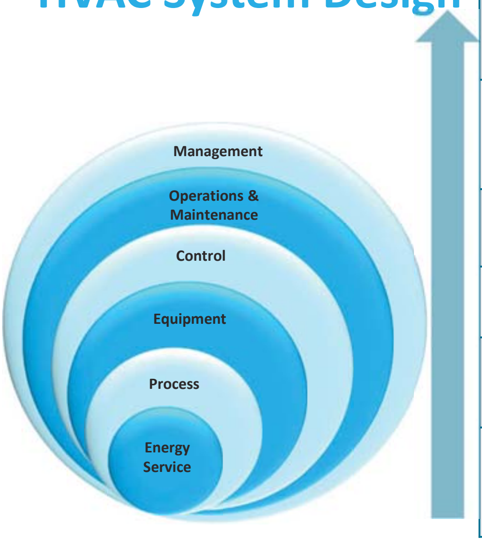
- HVAC loads i.e. fan loads, are generally fairly static.
- Where loads do vary based on occupancy, number of events, or production activity, energy demand should be monitored using EnPIs.
- Where HVAC equipment is dispersed around the site and difficult to measure, energy demand can be monitored at a building or distribution board level.
- Regular checks of HVAC operation would be required if metering is not in place.

MINISTRY OF INDUSTRY AND TRADE
Global Gateway
Funded by the European Union
UNIDO
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

HVAC Operation & Maintenance

- HVAC alarms should be set on BMS systems to identify issues.
- Regular HVAC checks should be carried out to ensure that systems operate effectively. These checks include:
  - Ensuring that dampers, coils and fans are operating as expected.
  - Ensuring that the temperature profile across AHUs makes sense.
  - Ensuring that filters and coils are clean.
  - Checking to see of setpoints have been altered.
  - Checking if pumps or fans have been placed in Manual mode.
  - Ensuring heat recovery systems are operational.
  - Ensuring that VAV boxes and reheats are operating correctly.
  - Ensuring that seasonal strategies have been engaged as required.
  - Ensuring that demand controls are operating.

HVAC System Design



Layer	Definition	HVAC Example Questions
Management	The on-going management of energy performance of the system	• Is the control strategy clearly documented so that we can use this for future reference? • Can we implement real time diagnostics to allow for automatic identification of inefficiencies?
Operation & Maintenance	The on-going operation and maintenance of the equipment	• Are AHU's easily accessible for the changing of filters and performance of maintenance tasks? • Have sufficient sensors been put in place to allow for performance monitoring e.g. filter differential pressure, intermediary temperatures.
Control	The control applied to the equipment	• Have VAV boxes been installed to allow for a reduction in fan speed when demand reduces. • Can CO_2 controls be used to reduce fresh air demand?
Equipment	The constituent parts of the process	• What is the highest efficiency AHU heat recovery system that we can get? • Have EC Fans been specified?
Process	The means by which the energy service is delivered	• Can we ventilate the space naturally, without any mechanical means? • Can we maximise free cooling/humidification using dampers and nighttime strategies?
Energy Service	The desired outcome that necessitates the consumption of energy	• Do we really need to ventilate the space? What is causing the need for ventilation? • Can we extract heat rather than cool spaces? • Do we really need dehumidification? Where is the moisture source? Can this be eliminated?

HVAC Case Study

AirWorks Ltd. operates a 3,500 m^2 mix of offices and light assembly. Two rooftop AHUs with VAV boxes, a 250kW air-cooled chiller, and a 150kW condensing boiler serve the building. Energy bills have climbed 20% year-on-year while occupants complain of hot/cold spots. An energy audit finds 24/7 schedules, outside air at twice the design requirement, a low supply-air setpoint that is fixed, constant fan speeds, and dirty filters. HVAC now uses 30% of site electricity.

What approach should the team take to reduce energy demand associated with these HVAC systems?

Production Equipment Basics

- Production systems vary greatly across sectors.
- The experts that can make the equipment run efficiently exist within every organisation.
- Our job is to assist them in understanding the energy uses within these processes so that they can develop the ideas.

Production Equipment Basics

- If we break most processes down to their core energy users we can see commonality across energy using equipment:

Asset List Development

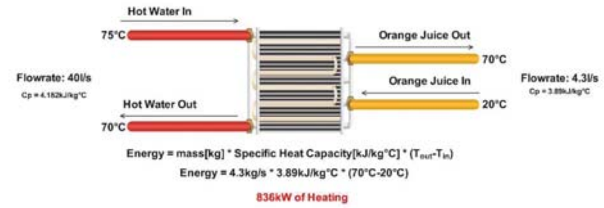
- Developing an asset list helps to understand the energy users and profile of the facility.

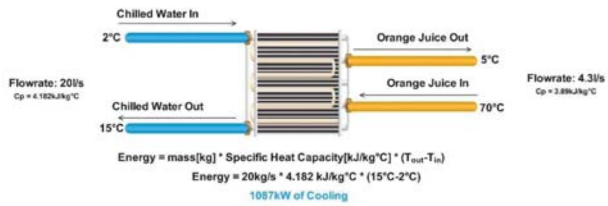
ID	Purpose	Name plate (kW)	Hours per year	Ave VSD speed (100% if fixed)	% name plate load	Actual Power (kW)	Annual Power (kWh)	Method of control	% of total	How were estimates made?	SEU
1	Cooling Water Pump #1	20	4,200	0.5	0.9	4.5	18,900	Differential pressure between system supply and return	2%	Hours run meter reading, estimate of speed, estimate of nameplate %	Refrigeration
2	Cooling Water Pump #2	20	4,200	1	0.9	18	75,600	Differential pressure between system supply and return	8%	Hours run meter reading, estimate of speed, estimate of nameplate %	Refrigeration
3	Process Transfer Pump	100	250	1	0.9	90	22,500	On/Off	2%	Hours run meter reading, estimate of speed, estimate of nameplate %	Process
4	Oil pump	1	8,400	1	0.9	0.9	7,560	On/Off	1%	review of operator logs, estimate of speed, estimate of nameplate %	Boilerhouse
5	Process heat recovery pump	10	8,400	1	0.9	5.76	48,384	Constant Speed On/Off	5%	review of BEMS data, other items estimated	Process
6											
7											
8											
9											
	Total						172,944		17%		
	Total electricity consumption						1,000,000	kWh per year			

Production Equipment Opportunities

- There opportunities are common across many systems including:
  - Challenging the energy service at a production level.
  - Discussing the need for strict setpoints with the quality department.
  - Optimising heat recovery.
  - Turning equipment off when not required.
  - Maintaining equipment effectively.
  - Maximising run times, throughput and reducing product waste.
  - Using variable speed drives.
  - Insulating.
  - Etc, etc

Process Heat Transfer

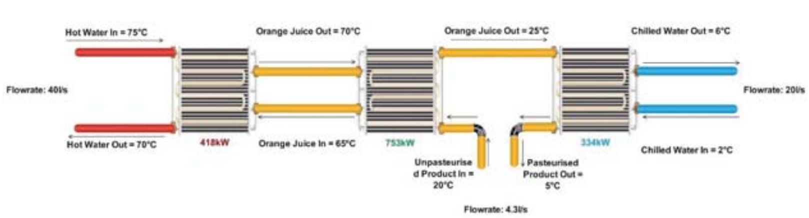




- Heating of product, water, air etc accounts for a very large proportion of energy in many businesses.
- It is important to recovery energy where possible and optimise energy flows.
- In this juice pasteurisation scenario product is heated and cooled in separate processes. If the process runs for 7,000hours per year:

- Heating = ((836kW * 7,000hrs)/90% Eff. Boiler) * $0.08/kWh = $520,177
- Cooling = ((1087kW * 7,000hrs)/4 COP. Chiller) * $0.15/kWh = $285,337
- **Total Process Running Cost = $805,514**

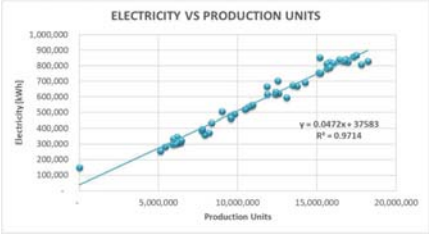
Process Heat Transfer



- Heating = ((418kW * 7,000hrs)/90% Eff. Boiler) * $0.08/kWh = $260,088
- Cooling = ((334kW * 7,000hrs)/4 COP. Chiller) * $0.15/kWh = $87,675
- **Total Process Running Cost = $347,763**
- **Saving = $457,751**

- We can use additional heat exchangers to recovery heat from product to product or air stream to air stream.
- This reduces the energy demand on chillers and boilers

Production Equipment Performance Monitoring



- In most factories, energy demand will be driven by some measure of production output.
- This may be kilograms, tonnes, units produces, or variations of product mix.
- Analysis will be required to determine the most appropriate energy drivers and energy data should be normalised against these values.

MINISTRY OF INDUSTRY AND TRADE
Global Gateway
Funded by the European Union
UNIDO
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Production Equipment Performance Monitoring

- Overall equipment effectiveness (OEE) is a key measure of production performance.
- If we can maximise OEE, energy performance improves.

$$Availability = \frac{Run\ Time}{Planned\ Run\ Time}$$

$$Performance = \frac{Actual\ Run\ Speed}{Design\ Run\ Speed}$$

$$Quality = \frac{Good\ Products\ Produced}{Total\ Products\ Produced}$$

Production Equipment Operation & Maintenance

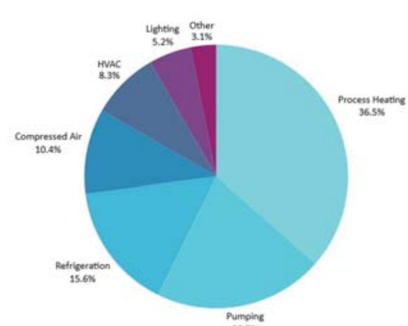
- Operation and maintenance requirements will be bespoke to the process.
- It is important that methods of maintaining energy performance are included in procedures and maintenance plans.
- Consult suppliers for maintenance activities which prevent energy performance deterioration.

MINISTRY OF INDUSTRY AND TRADE Global Gateway UNIDO

Production Equipment Case Study

- FruitFresh runs pasteurisation, rapid chilling, CIP and bottling over two 10-hour shifts, six days/week.
  Annual use: 2.6 GWh electricity and 1.1 GWh gas .
- Load profiles show weekday electricity peak of 620 kW with an overnight baseload of 310 kW
- Boilers are kept hot at all times as the maintenance team outlined that they have issues turning them on if they get turned off.

1. What opportunities do you think exist in this factory?
2. What information would you need to collect to prove your theories?
3. Could you estimate some initial savings that could be achieved?



Next Steps: Opportunities List Development

- 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	C02	Financial						kWh elec	kWh fuel	C02	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. Estiamte 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	Refrig	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

Next Steps: Set Annual Objectives & Targets

- Develop and communicate energy objectives and targets.
- Ensure project savings overshoot objectives in case some projects do not deliver.
- Assign responsibility for action plans.

Objective	Objective	Action Plan	Performance Improvement Expected
Improve Energy Performance by at least 20% in 2030	Improve Energy Performance by at least 5% in 2026	Optimise our building management system so that HVAC systems are performing as expected.	2%
		Carry out a leak survey on our compressed air system and fix leaks.	2%
		Implement energy performance indicators on large energy users and monitor them weekly.	3%

Energy Saving Calculation Formulae

$Energy = Power * Time$

$P = \sqrt{3} \times V \times I \times Cos\emptyset$ *where V=Voltage,* $I = Amps$ *,* $Cos\emptyset = Power\ Factor$

$P_{in} = \frac{P_{out}}{Motor\ efficiency}$

$Y = mx + C$ *where* $m =$ *Slope of the line,* $x =$ *Energy Driver,* $C =$ *constant/baseload.*

$Q = mCp(T_2 - T_1)$ where Q = Energy [kJ], m = mass [kg], Cp = Specific Heat Capacity [kJ/kg°C], T2-T1 = temperature rise or reduction in the system [°C].

What other formula do you use on a routine basis,
Lets list them out on the flip chart.

Reference Documentation to assist

- CIBSE https://www.cibse.org/
- ASHRAE https://www.ashrae.org/
- BAT https://bureau-industrial-transformation.jrc.ec.europa.eu/reference
- IEA https://www.iea.org/reports/energy-technology-perspectives-2024

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.

Questions?

Thank you!

See you tomorrow!

EU - VIETNAM SUSTAINABLE ENERGY TRANSITION PROGRAMME (SETP)

EE SME Trainer Training

UNIDO International Energy Efficiency and EnMS Training

Day 3

Delivered by: Richard Morrison, Colin Donohue

Housekeeping

- Emergency exits
- Toilets
- Mobile phones
- Breaks
- Lunch
- Please restrict email to break times

Day 1 Recap Six Step Programme for SME Energy Efficiency

Commit	•Review your current energy management situation •Commit some time and money to making improvements
Identify SEUs	•Understand your energy bills and review usage profile •Understand the large energy users
Monitor (EnPIs)	•Review and track your energy bills •Monitor the usage or performance of the big users
Operational Control	•Focus on the large users •Understand the small number of parameters that can make a big difference to performance
Take Action	•From the list of ideas, create an action plan •Include the Who, What, When and how much we will save in the action plan
Review	•Monitor and review improvements of the project after installation •Review the operation for more improvements

Recap on Day 1 and Day 2

Steam Boilers	•Water treatment focus via: TDS Levels, Condensate Return, •Equipment focus via Insulation, Combustion Efficiency, heat recovery etc.
Air Compressors	•Generation focus through: room temperature, moisture removal, pressure reduction, •Distribution focus via: pressure loss, leak reduction, appropriate usage etc.
Pumping	•Pumping improvement via, appropriate sizing, eliminate throttling, noise reduction, •Pumping system improvements via: Delta P, Delta T, cavitation, VSD controls etc.
Refrigeration	•Generation equipment via: head pressure control, condenser cleaning, insulation, •Distribution system via: Delta T, Minimisation of temp lift, insulation, valve controls etc.
Lighting	•Lighting on in unoccupied spaces, excess illumination, lighting replacement with LED. •Switching locations, use of Photo Cells and Motion Sensors, shutdown procedures.
HVAC	•Understanding of requirements, demand control such as temp, humidity and CO_2, •EC Fan replacement, Low Delta P filters, clean coils, valves heating & cooling etc.

Agenda for Today

Day 3 – Training Skills	
08:30 – 10:00	Effective Training Techniques
10:00 – 10:30	Break
10:30 – 12:00	Effective Training Techniques
12:00 – 13:30	Lunch
13:30 – 15:00	Unplanned training issues and communication styles
15:00 – 15:30	Break
15:30 – 16:30	Business Case and Case Stories

Purpose Of this Session:

- Design, deliver, and evaluate memorable training
- Hands-on practice: micro-teaching, job aids, coaching
- Consideration of different learning techniques
- Understanding the content from a learner perspective

What's In It For Me (WIIFM)

- Are you explaining the topic effectively?
- 91% of trainees say that trainers lack strong communication skills.
- Strong communicators are **clear** and **convincing**, able to **persuade** the trainees that the information being communicated is good for them and will give them the ability to do their job better (not easier).
- Message must resonate with the trainee.
- Messaging as simple as possible.

Recognise Change Management

Change is everywhere but people are resistant to change

A trainer needs to overcome this resistance

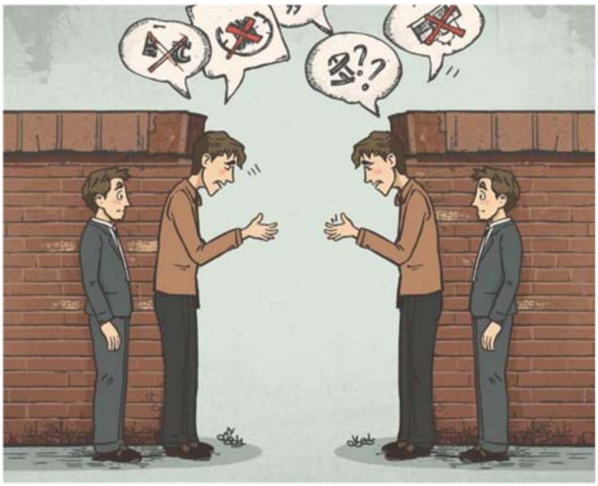
Need to create a "Burning Platform" to make a future state more desirable than the current state.

Preparing for a Training Session

- Training content design
  - Developing a Comprehensive Training Plan
    - Understand the Purpose and desired outcomes
  - Organising Presentation Material for Your Audience
    - Agenda, delivery method, content, flipcharts,
  - Choosing Effective Training Methods
    - Powerpoint, Flipcharts, Mindmap, Exercises, Breakout sessions etc.
  - The use of Visual Aids and Technology
    - Plan the visual aids to help with the learning, meters, instruments, photos, software etc.

Effective Communication

- Effective Communication Skills
  – Understanding the Communication Process
    - Clear concise communication
  – Assertive vs. Passive and Aggressive Communication
  – Recognising and overcoming communication barriers
  – Techniques for Effective Speaking including presenting with confidence and influence



Communication Barriers

Barrier category	What it looks like in session	Why it happens	Quick fixes (now)
Noise & environment	Hard to hear, side-talk, poor sightlines, glare, too hot/cold	Room setup, acoustics, lighting	Close doors, move to U/cabaret, adjust lighting/temperature, use a mic, set "one voice" norm
Language & jargon	Blank faces at acronyms; learners copy without grasp	Mixed language levels; heavy technical terms	Define acronyms; swap jargon for plain language; provide a glossary/visuals
Cognitive load	"Lost" after dense slides; note-taking stops	Too much, too fast; no structure	One idea/slide; chunk into 10–15-min modules; signpost ("now #2 of 3"); recap
Pace & delivery	Trainer races; monotone; minimal pauses	Nerves; time pressure	Slow key points; pause after questions; vary tone; use a visible timer, two trainers
Assumed prior knowledge	Some bored, others overwhelmed	Mixed experience; no pre-check	Quick diagnostic poll; offer optional "101" handout; pair novices with mentors
Cultural & power distance	Few questions; deference to seniors; silence	Fear of "losing face"; hierarchy	Use anonymous polls; Think–Pair–Share; invite specific roles to speak
Psychological safety	Learners avoid admitting confusion or errors	Past blame culture	Normalize "learning errors"; share your own mistake; praise good questions

Communication Barriers

Barrier	What it looks like in a session	Why it happens	Quick fixes (now)
Accessibility	Can't read slides; bad contrast; no captions	Visual/hearing differences; small fonts	32+ pt fonts; high contrast; read key text aloud; provide print/digital copies
Technology friction (incl. hybrid)	Logins fail; screen lag; remote can't hear	Unchecked AV; network limits	Tech check; backup media; repeat in-room questions into mic; assign a "remote champion"
Poor question technique	No one or the same 2 people answer	Overly broad or leading questions	Start easy (yes/no or poll), then "why/how"; wait 5–7 seconds; rotate responders
Misaligned incentives	"We're only here for the certificate"	Attendance is rewarded, application isn't	Open with WIIFM; link outcomes to KPIs; agree one on-the-job action
Conflicting norms	Phones out, late returns, side chats	No shared expectations	Set ground rules; co-create norms in 2 minutes; post them visibly
Stereotypes & bias	Voices from some groups ignored	Unchecked bias	Rotate who reports; call on quieter zones; acknowledge & redirect interruptions
Message design	Wall-of-text slides; tiny numbers	Slide-first thinking	Image-first; 6 lines max; highlight only the number that matters
Feedback barriers	Trainer can't tell if they're landing	No checks for understanding	Quick polls, thumbs up/side/down, 3–5 item quiz; "teach-back" in pairs

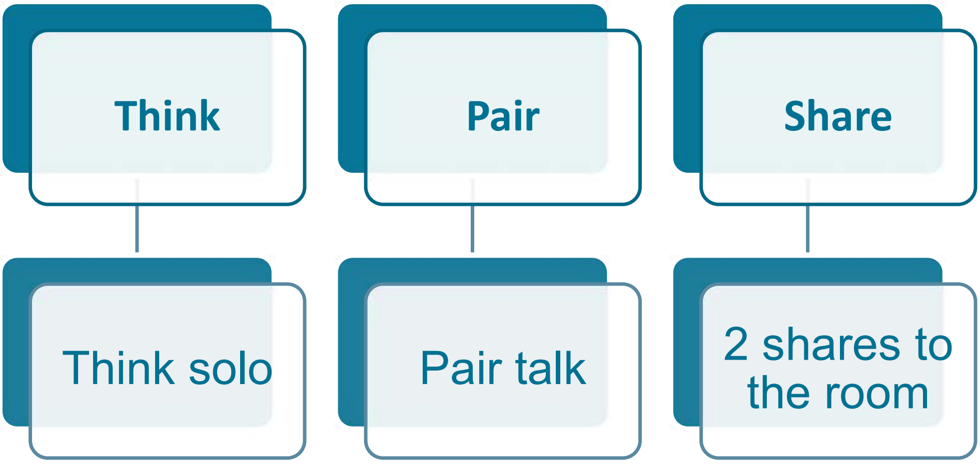
Engagement with the Audience

- Methods on how to engage with the Audience
  - Techniques to Grab and Maintain Attention by reading the audience
  - Interactive Activities to facilitate knowledge retention
  - Managing Group Dynamics and Interaction
  - Introduction to Effective Questioning Techniques including open, closed, probing questions, etc.
  - Providing Constructive Feedback

Effective Engagement Techniques

EXPLAIN | EXAMPLE | EXERCISE | FEEDBACK

Effective Engagement Techniques



Teachback Engagement

- Learners explain or demonstrate a skill back to peers and the trainer to prove understanding and get immediate coaching.
- It forces retrieval which is the strongest way to cement a memory
- It identifies misconceptions
- Confidence is built with the learner in a safe environment

- Most effective after a core step or module is complete

- More effective if trainer asks some **Why** and **How** questions to reinforce learning

Breakout Session

Group work allows for smaller groups to work together to explore the concept and apply the learnings. Use of flip chart and presentation back to the group

- Allows for more voices in the room
- Facilitates more interaction
- Most effective after a core step or module is complete
- Consider alternatives such as:
  - Different groups work on different issues,
  - Each person works on one piece and regroup to put it all together
  - Error finding, where a case story is given to a team and they need to find the issue.
- Trainer to move around the room during session to help and mentor the groups.

Demonstration

- Trainer demonstrates the concept slowly
- Learner observes the demonstration
- Trainer demonstrates the concept faster for fluency
- Follow-up exercise where learner applies the learnings.

Demonstration Technique Benefits

Make the abstract concrete. Learners see what “good” looks like—sequence, pace, and finish criteria.

Lower cognitive load. A worked example shows the whole task without forcing novices to problem-solve and learn simultaneously.

Dual coding = better memory. Visual + verbal channels reinforce each other.

Faster skill acquisition. Observational learning provides a ready-made template to copy, then adapt.

Confidence & buy-in. Vicarious success (seeing it done) boosts self-efficacy—especially for anxious learners.

Immediate feedback loop. Live demos expose misconceptions early and let you correct them in context.

Additional Engagement Techniques

Error hunt: show a common mistake; teams diagnose/fix using the job aid.

Polling: quick checks (A/B/C) to identify misconceptions and drive discussion.

Role play

Micro-practice: 3 short steps rather than one long exercise, increasing difficulty.

Engagement

- Start easy with Yes/No, then ask why or how?
- Practice "Psychological Safety"   Praise questions and normalise making mistakes during training
- Allow for 5-7 seconds to allow thinking on the topic, not blurting the answer
- Ensure for group participation that the report-out is shared
- Invite quiet learners into the conversation

Engagement

Keep in mind the voices in the room, effective communication requires active engagement.

If two trainers, one training, the other observing and enabling engagement (identifying and calling on the quiet participants)

Try some fun engagement techniques, encourage competition in the room, small prize for a table,

It’s Coffee Time

Agenda for Today

Day 3 – Training Skills	
08:30 – 10:00	Effective Training Techniques
10:00 – 10:30	Break
10:30 – 12:00	Effective Training Techniques
12:00 – 13:30	Lunch
13:30 – 15:00	Unplanned training issues and communication styles
15:00 – 15:30	Break
15:30 – 16:30	Business Case and Case Stories

Managing the Training Sessions

- Managing Training Sessions and Unforeseen Circumstances
  - Timing and following the agenda
  - Starting and Ending a Training Session and managing nerves
  - Improvising and Thinking on Your Feet
  - Handling Delays, Technology Failures, and Difficult Audiences

Importance of the Agenda

- Provides Focus and relevance
- Ensures Cognitive load control by breaking the content into manageable chunks
- Time and energy management
- Expectation setting
- Scope control: lets you park off-topic items and negotiate changes without derailing the session.
- Accountability: aligns outcomes with activities and assessments; makes it easy to evaluate success

Managing your nerves at the start

- Arrive early and check slides, projector flip chart, lighting etc.
- Rehearse your opening slides
- Set up the props, flip charts etc
- Ensure the clicker works
- No obstructions if you walk around.

- Deliver the first 3 minutes with confidence and ease into it for the rest of the day
- Maintain eye contact, (Use a triangle, Back left, Front Centre, Back right)
- Hold your marker, clicker at waste height to avoid fidgeting

Things to manage during the Presentation

- Take a sip of water if nervous and recap on earlier learnings
- Use the room: “What do you think?”
- Own a stumble: smile, “Let me restate that,” then say it simply.
- Brain blank: “Let me restate that simply…” (repeat the question), glance at your slide/job aid, then answer one point; offer to follow up on the rest.
- Do not know: "Great question. I'll park it and send a clear answer after lunch.”
- Dominant participant: “Thank you. I would like to hear from someone who has not spoken yet?”
- Tech fail: "While this reloads, pair up—list two steps you would take next.”

Challenging Behaviour and appropriate response

Behaviour	Respectful, low-heat response	Preventive move
Side conversations	"Let's keep one conversation so we can hear this step." (Pause. Smile.)	U-shape seating; "one voice" norm on Slide 1.
Dominates / interrupts	"Thanks—let's hear from someone who hasn't spoken yet. Perhaps operations?"	Round-robin or "three hands then move on."
Challenger / sceptic	"Great—let's test that on the next example and compare." (Write on parking lot if big.)	Open with WIIFM + success metrics; acknowledge costs/concerns.
Know-it-all	"That's advanced and useful. After this core step, could you demo your tip?"	Invite them as peer coach for one activity.
Off-topic digressions	"Parking that so we finish Step 3. We'll return at 10:40." (Point to visible "Parking Lot".)	Timeboxed Q&A; visible agenda with checkpoints.
Disengaged / on phone	"Quick pair task—circle the error in Step 2." (Walk near, include them by name next.)	Frequent micro-tasks; clear device policy; give standing table at back.
Late returners	"Glad you're back. We're on Step 2—join this group and start at the checklist."	Break clock on screen; announce "starts sharp at :05."
Negative/cynical comments	"Sounds frustrating. What would 'good' look like? Let's try one small change here."	Start with a success story; agree "criticize ideas, not people."
Quiet/reserved	"Take 30 seconds to jot your idea—then I'll hear from the back row."	Think–Pair–Share; anonymous polls to warm up voices.

The Close

- Confirm the Learnings
  - 3-6 key learning outcomes
  - Ideally re-enforced by the learners, quiz or other method
- Address parking lot issues identified or follow-up mechanism to close them
- Next Steps
  - Slides, material, certification, follow-up etc.
  - Attendance record and feedback forms completed.

Thank the learners for their participation

Finishing Time

- Respect your time and respect other peoples time
- Always finish on time or before time as per the agenda

Difficult Encounters during Training

- Dominant person in the room
- Mind Blank during training
- Trainees mismatched to materials

- What other difficulties have been encountered during training?

Presentation delivery

Do

- Eye Contact
- Read the room
- Change the pitch of your voice
- Stand with confidence
- Deliver with confidence
- Tell a story
- Put your phone on silent
- Respect time.

Dont

- Read slides verbatim,
- Have long lectures without checks,
- Ignoring non-verbal cues,
- Argue with sceptics in public
- Turn your back on the room
- Take a phone call
- Expect others to respect you if you do not respect the learners

Challenging Audience

- Even the most well planned training sometimes goes wrong
- Need to maintain composure
- Deal with the issue
- Remember even a swan looks graceful on the surface
- Be a Swan...

Difficult Audiences

Type	Telltale signs	Your goal	Do	Don’t
Sceptical/hostile	Crossed arms, challenges, “this won’t work”	Lower threat, test ideas together	Acknowledge, run a micro-experiment/case, invite data	Argue theory vs theory
Dominant experts	Frequent interruptions, long monologues	Harness expertise	Give a role (co-coach, demo lead), timebox	Publicly shut down
Silent/low-participation	Few questions, low eye contact	Create safe entry points	Think–Pair–Share, anonymous poll, call by role	Cold call individuals early
Mixed seniority	Juniors quiet, seniors speak	Balance voices	Round-robin by table/role; “two-comment” rule	Let hierarchy dictate airtime
Disengaged/multitasking	Phones, side chats	Re-engage with action	60-sec pair task, proximity, engineered nozzles of interaction	Scold publicly
Time-pressed execs	“Get to the point,” watch clocks	Deliver outcomes fast	Start with What is in it for me, show decision slide early	Warm up slowly
Remote/hybrid lurkers	Cameras off, no chat	Pull them in	Directed questions by name/role, chat prompts, rotate reporters	Talk only to the room

Training Delivery Challenges

- Go through your training experiences to date. Discuss the challenges that you came across and how you addressed the challenge during the training. What would you do differently if encountered with the same challenge again?

Part 1: Focus on Training Preparation.

Part 2: Focus on Training Delivery methods.

Part 3: Focus on learner engagement.

Part 4: Focus on conflict resolution.

See you in 45 minutes!

Agenda for Today

Day 3 – Training Skills	
08:30 – 10:00	Effective Training Techniques
10:00 – 10:30	Break
10:30 – 12:00	Effective Training Techniques
12:00 – 13:30	Lunch
13:30 – 15:00	Unplanned training issues and communication styles
15:00 – 15:30	Break
15:30 – 16:30	Business Case and Case Stories

Unplanned Training Issues

- With the best laid out training plan, clear agenda and great material, training can still be impacted by a myriad of issues
- How we deal with the issues will impact on the participants experiences
- Positive reaction to issues is key to a successful outcome
- Take a deep breath before reacting to an issue.
- Do not say or do anything to impact on the learning outcomes of others in the training that you cannot stand over

Technology Failure

Reassure the Room

Technical blip, bear with me for 5 minutes while we get back on track.

In the meantime in groups discuss the following……

Fall Back approach

Use offline version

Use hard copy of materials

Projector fails, use laptop

Use flipchart

If all else fails, take a 5 minute coffee break.

Issues and potential solutions

Issue	Immediate move	Backup materials
Projector won't display	Seat closer in a **U-shape**; teach from **flip-chart**; narrate key slide	Printed 3 key slides + job aid
Platform/login failure	**Screenshots** walk-through; paper forms/cases; pair critique	PDF of screens; "paper system" pack
Wi-Fi down	**Offline file** / local video; sketch data flows on board	Offline dataset; diagram handout
Audio failure (video/demo)	**Mute video**, narrate steps; post link for later	Captioned transcript; summary slide
Late start (-20 min)	Drop 1 example, keep main **exercise**; shorten debrief	Pre-written debrief prompts
Overlong discussion	Park it visibly; **timebox**: "1 more comment, then we move"	Parking-lot sheet with return time

Discuss the following as part of a round the room exercise

- Late Start
- Technology Failure
- Mixed levels in the room
- Low attendance
- Time Overrun
- Dominant participant
- Silence or no participation
- Resistance to the topic
- Telephone / Email distraction
- Accessability issue Cant read slides or obstruction in room
- Noisy room
- Content mismatch
- Conflict
- Hybrid friction

Unplanned Issues

Issue	Early sign	Do now (≤2 min)	Prevent next time
Late start / lost time	People trickle in after the published start time	Announce a compressed plan: merge examples; keep one core practice; show timer	Start-room open 15 min early; pre-flight checklist; arrive-by policy in invite
Tech failure (projector/Wi-Fi/app)	Black screen, login loop	Launch pair task ("List steps for X") while you swap to PDFs/screenshots/flip-chart	Carry PDF copy + screenshots; offline dataset; adapters/batteries; printed job aid
Wrong audience / mixed levels	Blank stares or "we know this"	Split task: basics work checklist; advanced do "error hunt" on a harder case	Pre-diagnostic (3 Qs); stream tracks or optional 101 primer
Low attendance / key voice missing	50% turnout; sponsor absent	Run as small group session for attendees; capture decisions to brief absentees	Confirm attendance 24 h prior; get sponsor to send commitment note
Time overrun (Q&A or debate)	Clock slips; long monologues	"One more comment, then we move"; park items on visible sheet with return time	Agenda with buffers; ground rules; timebox discussions
Dominant participant	Same voice answers everything	"Thanks—let's hear from someone who hasn't spoken yet" assign them reporter role	Round-robin by role; rotate table roles; brief norms up front
Silence / low participation	No hands; heads down	Think–Pair–Share (2–2–2); then call by table/role	Build interaction every 10–15 min; use anonymous polls early

Unplanned Issues

Issue	Early sign	Do now (≤2 min)	Prevent next time
Scepticism / resistance	"This won't work here"	"Let's test it on the next case and compare"; log concern	Open with WIIFM and risk of not changing; include local data/case
Side conversations / phones	Whispering, scrolling	Proximity and "One conversation so we can hear this step—thanks"	Co-create norms; frequent micro-tasks; seats in U/cabaret
Accessibility hiccup	Can't read slides; bad sightline	Read key text aloud; hand out printouts; adjust seating	32-pt fonts; high-contrast slides sent ahead; check access needs
Safety concern	Confusion at hazardous step	Pause; restate safety controls; demo slowly; defer hands-on if unclear	Safety brief slide; PPE check; step-by-step job aid
Noisy room / interruptions	HVAC/nearby meeting noise	Close doors; move closer; use mic; summarize top line only	Book suitable room; test acoustics; signage "session in progress"
Content mismatch to job	"We don't do it that way"	Ask for their variant; map steps to your checklist; note gaps	Pre-interview SME; capture site-specific screenshots/flows
Emotional heat / conflict	Raised voices; cross-talk	Call a brief pause; restate norms; offer break or private chat	Stakeholder brief; agree escalation path; parking-lot protocol
Hybrid friction	Remote can't hear/see	Repeat questions into mic; chat check-ins; rotate remote reporters	Co-facilitator for chat; tech check; shared docs for exercises

Communication Styles

- There are many communication styles that work in the delivery of training
- Best to change the communication style to cater for the audience
- Adapt to best suit the room
- Need to be able to gather feedback from the crowd

Communication Styles

Style	Best for	How to do it (moves & phrases)	Watch-outs
Directive / Instructor	Safety steps, compliance, new critical procedures	"Do X, then Y. Watch for Z." Use step lists, demos, check-backs.	Overuse = passive learners; keep segments short and follow with practice.
Facilitative	Drawing out experience, solving real problems	Ask, paraphrase, synthesize: "What patterns do you see?", "I'm hearing…"	Can drift; timebox and park off-topic threads.
Coaching	Building confidence, skill on the job	Open Qs + goal/action: "What's your next step?", "What would make it easier?"	Avoid turning it into therapy; keep tied to outcomes.
Question-led	Critical thinking, decisions, diagnostics	Laddered questions (what → why → how); use silence (5–7s).	Too many puzzles = fatigue; seed answers if the room stalls.
Demonstrative / Show-and-tell	Tools, software, hands-on tasks	Narrate intent → slow demo → replay fast → learners do it.	Don't narrate clicks only—explain why.
Storytelling	Change buy-in, memory & meaning	Short real story → tension → resolution → lesson: "So the takeaway is…"	Keep stories <90s and relevant; avoid hero speeches.
Collaborative / Peer-led	Mixed expertise rooms, knowledge sharing	Think–Pair–Share, round-robins, gallery walks; assign table roles.	Dominant voices; design for equal airtime.
Data-driven / Analytical	Leaders, sceptics, technical audiences	One chart = one message; say the implication: "This 14% drop means…"	Drowning in numbers; highlight only the number that matters.
Empathetic / Supportive	Resistance, anxiety, error-prone tasks	Validate → boundary → next step: "Makes sense this is tricky.	Over-soothing can reduce pace; return to action quickly.

Communication Failure leads to Boredom

- Biggest training risk is monotone, one voice and boredom

- Boredom is an unpleasant psychological state of uninterest and dissatisfaction with one's surroundings or a lack of meaningful engagement or stimulation.
- It can manifest as apathy, restlessness, or fatigue and is a signal that your current environment or activities aren't meeting your cognitive or emotional needs.

Use Storytelling Techniques to Keep Attendees Interested

- Training is not just data, formulas, and facts its about ***connection.***
- Avoid being a "Total Engineer" : overly technical, detail heavy, and detached.
- Storytelling makes content **memorable** and **relatable**.
- Personal stories bring concepts to life and humanise the trainer.
- Stories help learners see **why** the knowledge matters, **not** just **what** it is.
- Effective storytelling builds trust, engagement, and long-term retention.

Storytelling Format

Problem – Set the scene with a real-world challenge.
"I had a meeting one time with a production manager and energy manager of a site that was legally required to carry out an audit."

Challenge – Highlight the difficulty or barrier.
"The production manager started the meeting by saying –" *Just to let you know, I do not care about energy efficiency and do not believe in that climate change stuff"*

Solution – Explain the action taken or method applied.
"Rather than try to convince the manger otherwise, we discussed the cost of energy per unit price of production, and some means by which the cost per unit could be reduced."

Result – Share the outcome or benefit.
"In the end we spent four hours walking the production line with the manager brainstorming ideas."

Lesson – Reinforce the takeaway for learners.
"We need to direct our efforts towards what motivates different people to take action."

Discussion

How do we overcome boredom in a training session?

What skills can you use to overcome boredom in the room?

Exercise

Develop a presentation of the business case for the adoption of energy efficiency solutions from an audit

- Presentation summary
- Presentation of the output of the audit to senior management (the room)
- Clear business case presentation with the output clearly communicated to management

It's Coffee Time

Agenda for Today

Day 3 – Training Skills	
08:30 – 10:00	Effective Training Techniques
10:00 – 10:30	Break
10:30 – 12:00	Effective Training Techniques
12:00 – 13:30	Lunch
13:30 – 15:00	Unplanned training issues and communication styles
15:00 – 15:30	Break
15:30 – 16:30	Business Case and Case Stories

Audit Report

- Should outline the extent of the investigations taking place.
- Current state (benchmarking if possible)
- Opportunities for improvement
- Clear Recommendations in the summary (for management)
- Detailed technical information in the body of the report (for technical department)

Audit Report Recommendations

1. Executive Summary
   - Energy consumption and costs
   - Comparison of performance against known benchmarks/EnPIs Most significant opportunities for improvement
   - Assessment of current energy management practices Recommended next steps.
   - It should also convey the key messages and recommendations from the auditor in order to enable senior management to implement the report recommendations and improve the organisation's energy performance.
2. Introduction
   - Brief outline of the scope of the audit, the activities covered by the energy audit, an overview of the client organisation and its day-today operations
3. Energy Usage
   - Outline the energy consumption of the various sources, including macro consumption data
4. Significant energy users (SEUs)
   - For each significant energy user, the following information should be provided: 1. Process descriptions 2. Description of current state and opportunities for improvement 3. Engineering calculations and financial calculations as appropriate.
5. Recommendations
   1. the opportunities for improvement should be assessed and prioritised in order to determine the most appropriate opportunities for improvement.
6. Metering Requirements
   - Document the current measurement systems in place and the recommended metering required in order to accurately measure the energy performance of the organisation through active energy management.
7. Renewable Energy Technologies.
   - Discuss the various renewable energy technologies assessed as part of the audit.

What is the purpose of the presentation to management

"I have made this letter longer than usual because I have not had time to make it shorter"

The Senior management presentation output should be short sharp and to the point.

Consider the Elevator Pitch on the next slide

The Elevator Pitch

- **Who is it for** – The decision makers in the organisation
- **Problem** – The pain current energy consumption cost and CO_2 & trends
- **Value** – Outline the improvement potential?
- **Proof** – Summarise the big opportunities
- **Ask** – The next step you recommend

E-learning platform

E-learning platform designed to help SMEs increase their energy efficiency and reduce their energy related costs.

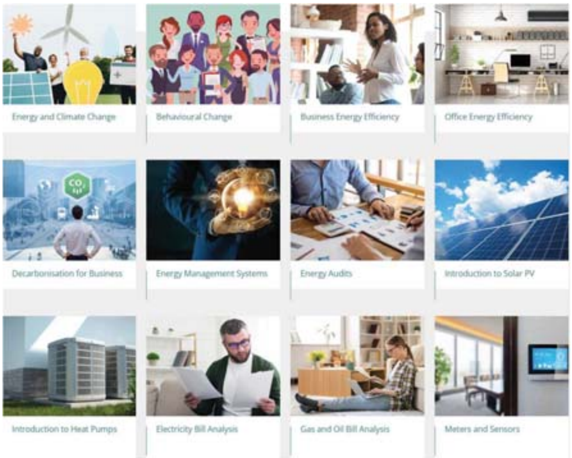
- Self passed learning
- Ideal for busy SME owners and managers
- Free on line resource
- Designed to use when it suits the manager

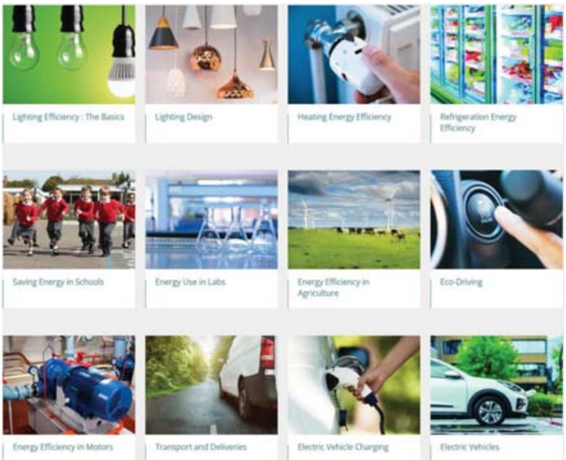
Step by Step approach to energy efficiency

- Step 1. Understand your energy use
- Step 2. Create an energy action plan
- Step 3. Complete an energy audit
- Step 4. Invest in energy efficiency upgrades and renewables
- Step 5. Monitor, track and report
- Energy Management Guide and Workbook

MINISTRY OF INDUSTRY AND TRADE · Global Gateway · Funded by the European Union · UNIDO UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

E-learning Modules Available





Examples of On Line Learning

E-learning

- SME Leaflet
- Energy Efficiency Guide for Retailers
- SME Guide to Energy Efficiency
- Switching to Electric Vehicles: A Guide for Businesses
- Energy Efficient LED Lighting: A Guide for Businesses
- SME posters

E-learning Platform

- https://www.seai.ie/plan-your-energy-journey/for-your-business/steps-to-energy-efficiency
- https://www.seai.ie/about/tools/energyacademy
- https://www.climatetoolkit4business.gov.ie/
- https://www.se.com/ww/en/about-us/university/

E-learning Modules

- What e-learning Platforms have you used?
- Are they broadly used in Vietnam?
- Would the SME sector use them?
- What topics should be developed?

Plastics Company Audit in Hanoi

Opportunities for Improvement Identified:

- Compressed air leaks
- Improve the operating efficiency of the chiller water pump to cool manufacturing equipment
- Install an electromagnetic heating system to replace the resistance heating
- Replace the resistance heating with infrared heating for manufacturing equipment
- Clean the chiller circulating water of scale
- Install a harmonic filter to reduce the impact of harmonics

2% energy savings identified on site

Detailed process descriptions in the report

Some operational control savings identified with detailed calculations

Temporary metering installed to support the calculations

Plastics Company Recommendations for Improvement

- Focus on Audit Scope
- No breakdown of energy within the facility
- Significant thermal image survey of electrical panels but no image of chilled water system
- The images provided in the audit report outline some aged equipment, audit report should recommend:
  - Air compressor replacement
  - Chiller replacement
  - Cooling tower upgrades

Opportunities for improvement were contained in Page 79-114, Consider moving the opportunities to earlier in the report.

Hospital Audit in Dong Nai Provence

Opportunities for Improvement Identified:

- Management system improvements
- Air Conditioning smart controller
- Solar Hot Water System
- Heat Insulating film on windows
- Solar PV

15% energy savings identified on site

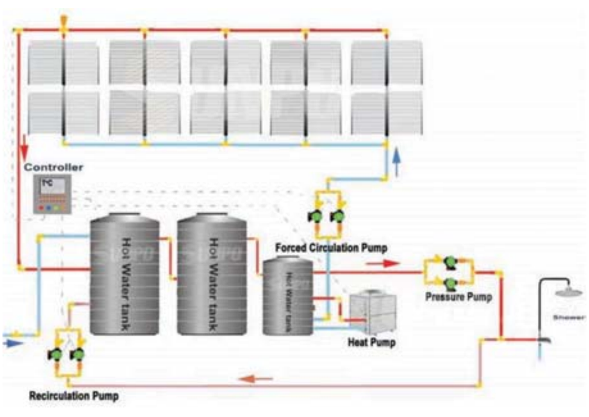
Detailed description of the hospital in the report

Some operational control savings identified with detailed calculations

Temporary metering installed to support the calculations but limited duration

Hospital Audit in Dong Nai Provence Recommendations

- No breakdown of energy within the hospital
- Surprising that there are no fan savings in the hospital "No potential for energy saving"
- Metering should extend to out of hours monitoring also
- Report includes hot water discussion surrounding central system with heat pump but was not included in overall recommendations.



Agri Company Audit in Hà Nam

Opportunities for Improvement Identified:

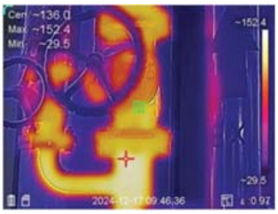
- Enhance management solutions and complete energy management system
- Insulate steam pipe valves
- Check and monitor compressed air leaks
- Install active harmonic filter
- Add excess air control system to boiler

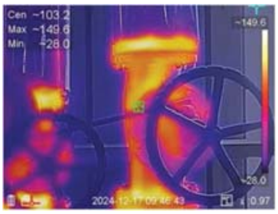
The company's key energy consumption systems, include:

- ➢ Production machine system;
- ➢ Lighting system;
- ➢ Fan system;
- ➢ Pump system;
- ➢ Air compressor system;
- ➢ Refrigeration and air conditioning system;
- ➢ Boiler system.

Agri Company Audit in Hà Nam Observations

- Very good boiler system analysis
- No breakdown of energy within the facility
- There should be opportunities for improvement in each energy using system.
- The report identified an air compressor operating Load / Unload and no recommendation to install a VSD.
- Great to see energy related thermal images and the UNIDO tools in this audit report.





Livestock Company Audit Recommendations

Opportunities for Improvement Identified:

- Compressed Air Leaks
- Boiler Combustion Control

Total savings 135,000 kWh p.a. or 0.5% of facility energy.

The Audit report should go into more detail surrounding the energy users within production.

The feed mill has significant electrical users including milling and blending and not mentioned in the report.

Focus was on the steam system which has already received significant investment in 2022.

Malt Processing Company Audit

- Good Electricity Breakdown
- Gives focus on the largest energy users during the audit
- Energy savings of 28% of the site energy identified.
- Excellent analysis of the data available
- Air compressor trended over one month,

- Good analysis of energy V production in graph and regression against relevant variables.

Audit Conclusions

Positive Observations	• Some very good recommendations being made • Clear analysis being carried out on some audit reports • Comprehensive reports being developed 80-140 pages of work.
Recommendations:	• Develop an Energy Balance and focus on the SEU’s • Stay within the audit focus, emergency generators should not be a focus • Raise the level of ambition with the auditors, think bigger

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.

Questions?

Thank you!