Energy Management System (EnMS) Implementation Training

Trainers

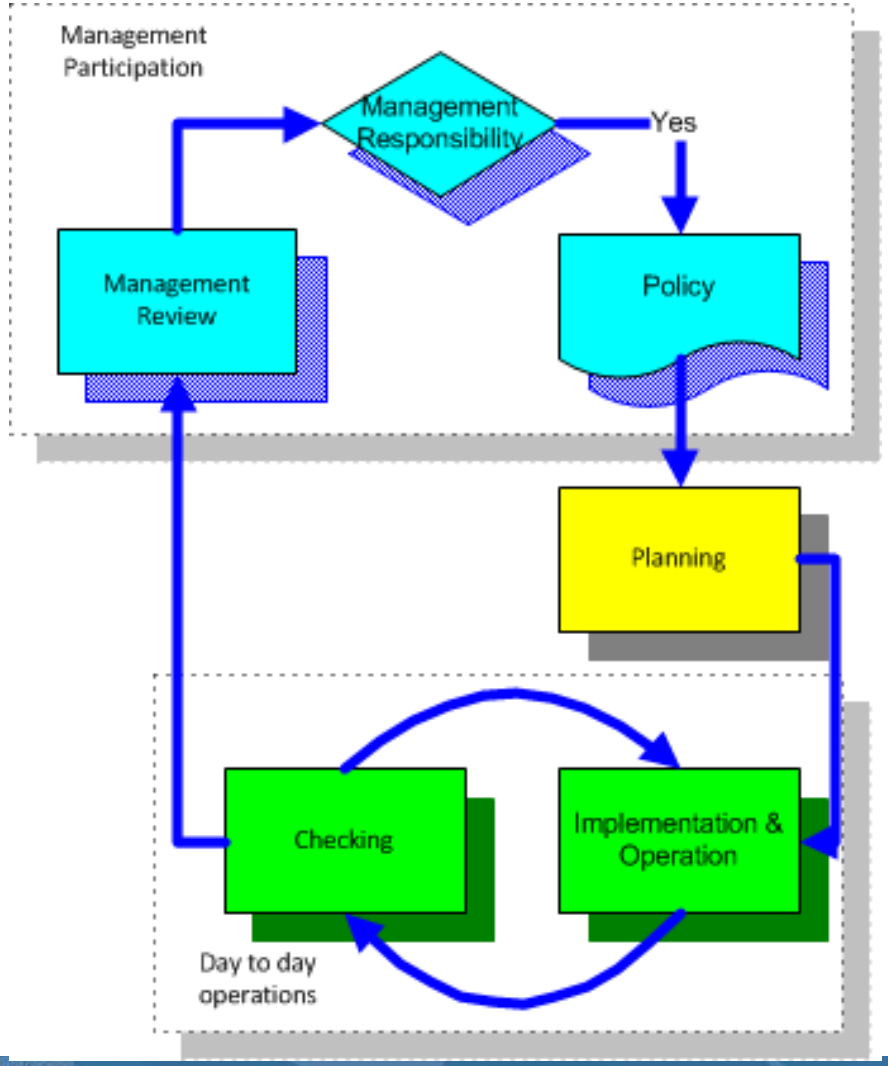
UNIDO International Energy Efficiency Experts

Day 2

Based on the contents of the UNIDO EnMS Student Training Manual

Country
Date

What did we do yesterday?



Based on the concept of:

- **Plan**
- **Do**
- **Check**
- **Act**

Day 2

Day to day operations - part 2 and tool demo	1.25		08:00	09:15
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Operational Control

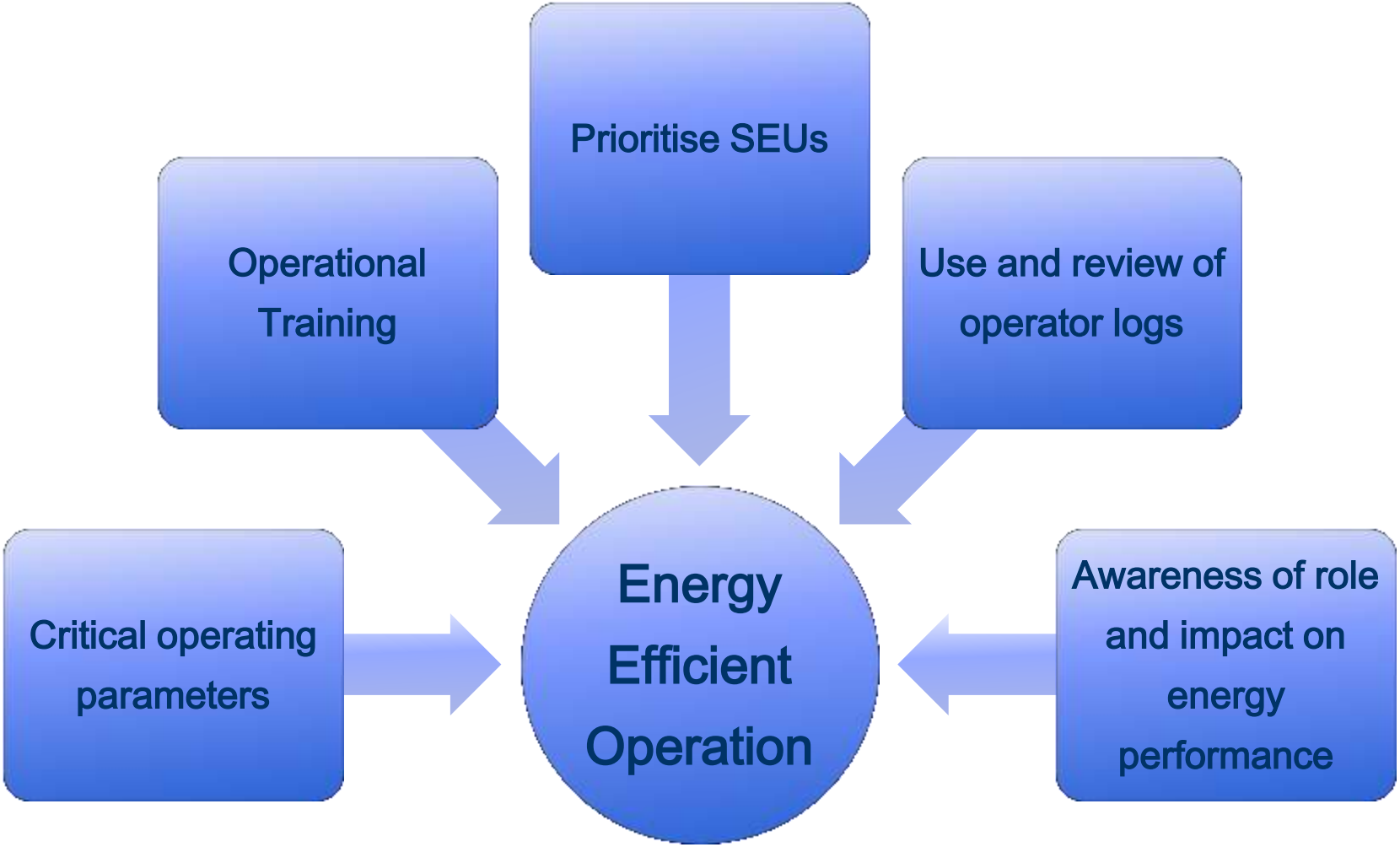
- This is a very critical part of the EnMS
  - Only a small part of ISO50001 and others
- Significant energy using equipment operation
  - Operating parameters
  - Operating procedures
  - Logging (electronic and manual)
- Maintenance of Significant energy using equipment
  - Maintenance procedures and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

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

This area is very commonly neglected

It is not difficult

Energy Efficient Operation



Operational Control - Operation

- How should the system/equipment be operated?
  - Operation manuals from manufacturers
  - Operation manuals for systems including interaction of equipment and automated controls and end use
  - Operating procedures
  - Operator logs
- Training
- Communication
- Management and control
  - Checking operations
- Does everyone know what can and should be switched off and when?

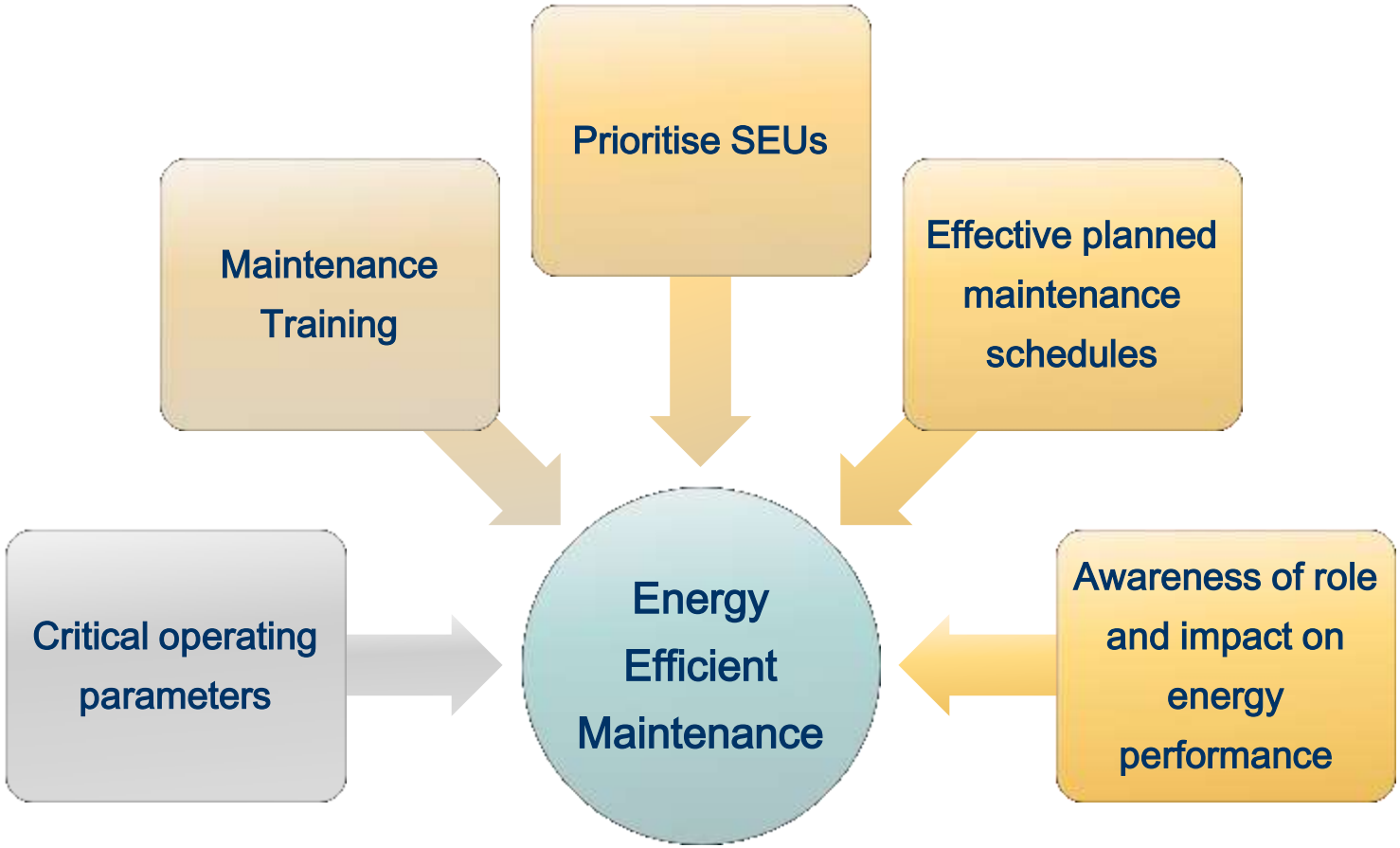
Operator Logs

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

Critical operating parameters

SEU (inc use)	Parameter	Eng Units	Normal set point	Upper Limit	Lower Limit	Measuring Instrument	Calibration Frequency	Who needs to be informed?	Note
Steam system	Total Dissolved Solids	ppm	3500	3800	3400	TDS001	3m		
Steam system	Boiler Pressure	bar	9.5	10	9	PT123	12m		
Steam system	Exhaust Oxygen	% O2	3	3.5	2	Portable 2123	12m		
Steam system	Stack Temperature	DegC	N.A.	300	N.A.	TT124	12m		Varies with firing rate

Energy Efficient Maintenance



Operation control - Maintenance

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

Maintenance options

- Preventive maintenance
- Predictive maintenance
- Reliability centred maintenance (RCM)
- Overall equipment effectiveness (OEE)
- Total productive maintenance (TPM)

- Note: reactive maintenance may be appropriate for items that are relatively unimportant in terms of reliability and energy use

Maintenance criteria

SEU (inc use)	Task	Frequency	Who needs to be informed ?	Note
Steam system	Statutory inspection	12 monthly		
Steam system	Combustion testing	3 monthly		
Steam system	Chemical treatment testing	weekly		

Behaviour Change – operation control

- "We have always been operating (maintaining) things this way"
- "Why do we need to change?"
- "Production is critical – if we change something we may affect production"

- Change is uncomfortable
- It is difficult to sustain
- Communication is very important

- Discuss difficulties and solutions re: operation control

Implement the action plan

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

- Sort out any systemic barriers

Causes of failure to complete action items

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

Communication

- On-going communication is required to embed the EnMS in your organisations culture
- You need to communicate with your staff:
  - Energy policy
  - Energy awareness
  - Progress on energy management
  - Success stories
- You need to give them an opportunity to contribute
  - Ideas and suggestions
- You need to decide if external communication is required
  - What, when, how and by whom
  - Some will be required under “other requirements”, e.g. environmental licencing, emission trading, etc.

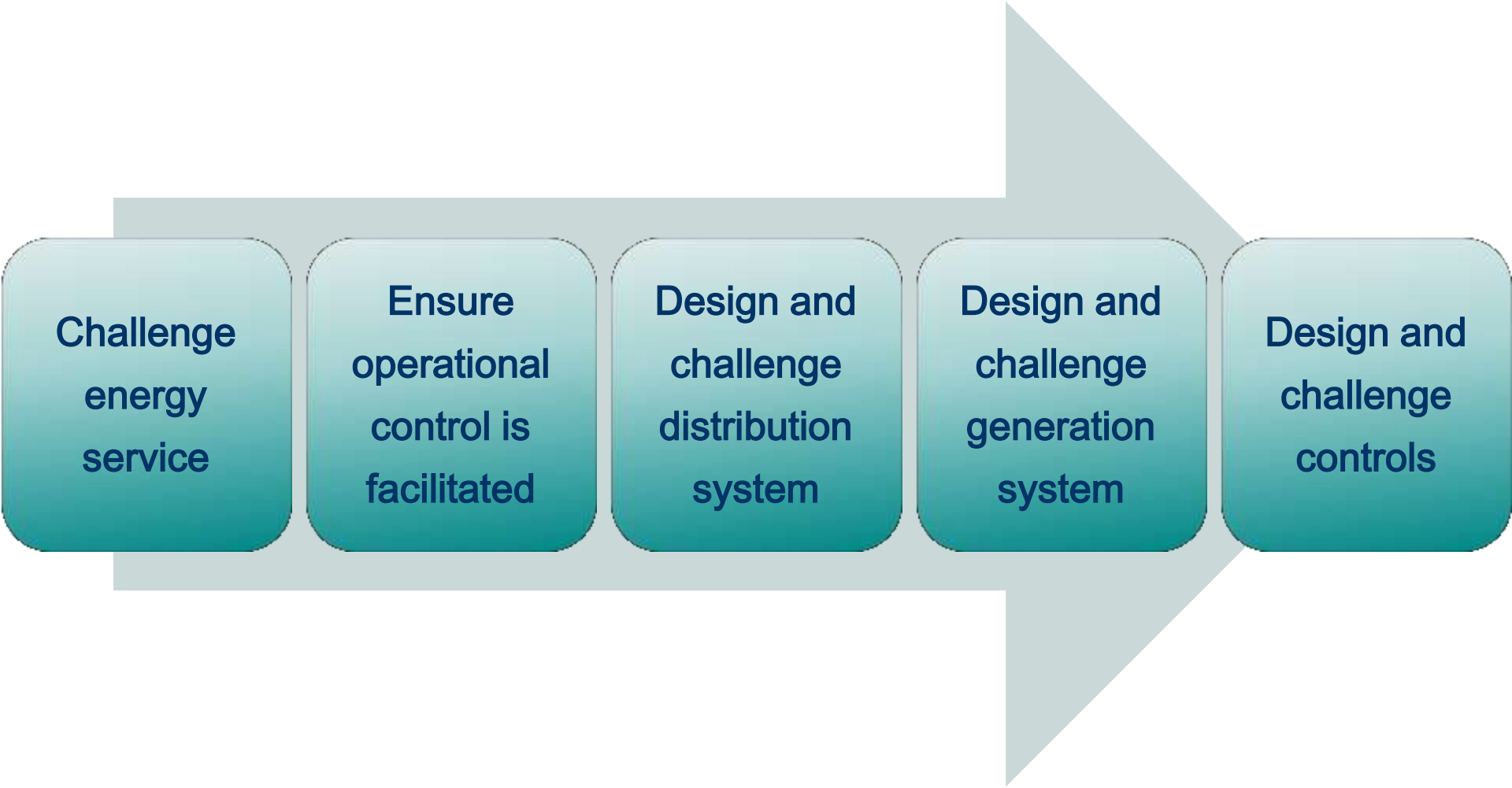
Communication methods

- Posters
- Email
- Intranet
- Noticeboards
- Staff newsletters
- Energy displays
- Awareness days and campaigns
  - Piggy back on national campaigns
- Communication meetings or seminars
- Induction training

Design – Energy Efficient Design (EED)

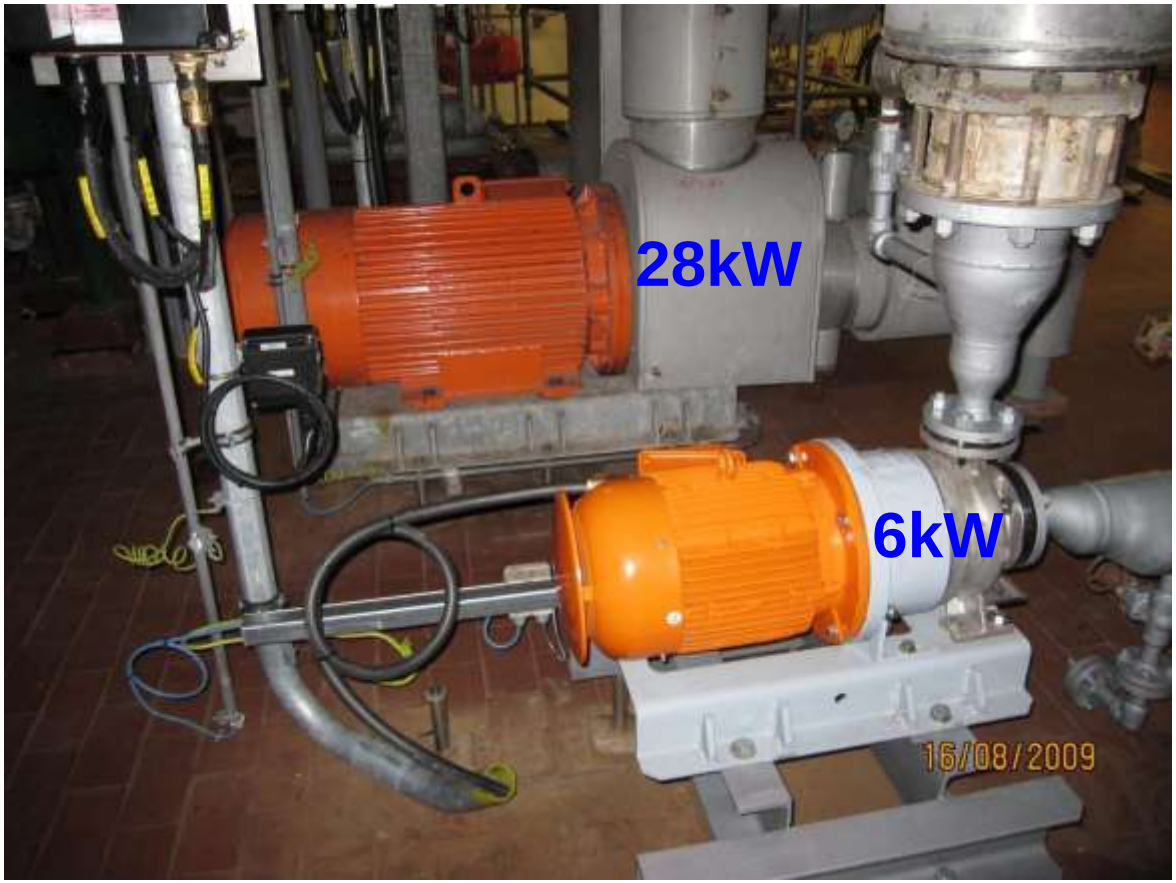
- Major opportunity to improve
- Technical Changes
  - Expansion, refurbishment, replacement
  - Facilities, equipment, systems and processes
- Energy Efficient Design
  - Challenge user specification, use, distribution, generation

EED


Challenge energy service
Ensure operational control is facilitated
Design and challenge distribution system
Design and challenge generation system
Design and challenge controls

Pump system example

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



Energy Efficient Design (EED)

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

Energy Efficient Design workflow

- Design a workflow that suits your processes
- Involve energy expert at an early stage
- Have an energy design review as early as possible
  - Challenge user requirements and specifications
  - Ideally at the conceptual design stage
  - It may be too late once drawings are produced.
- Agree which measures will be included
- Include operation control

The importance of commissioning

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

Procurement

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

Purchasing energy

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

Purchasing goods

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

Purchasing services

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

What about purchasing energy saving technologies?

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

Outputs from Imp & Op

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

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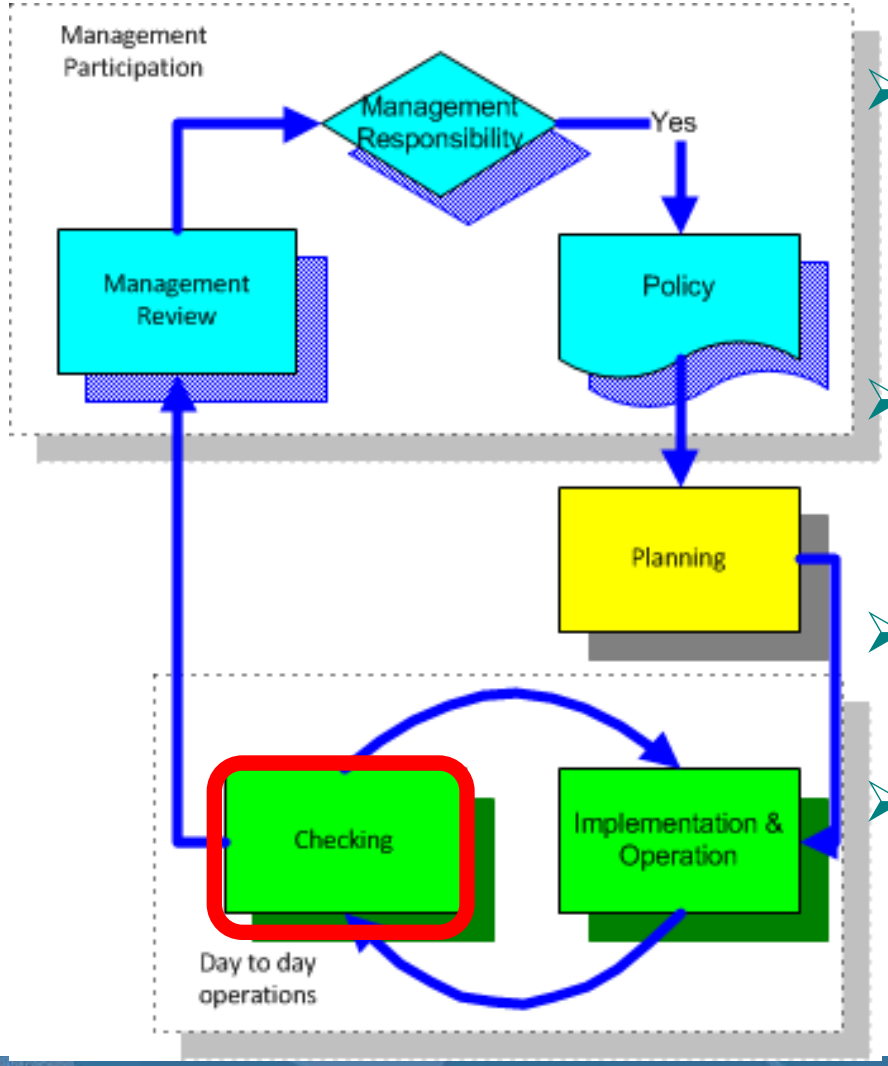
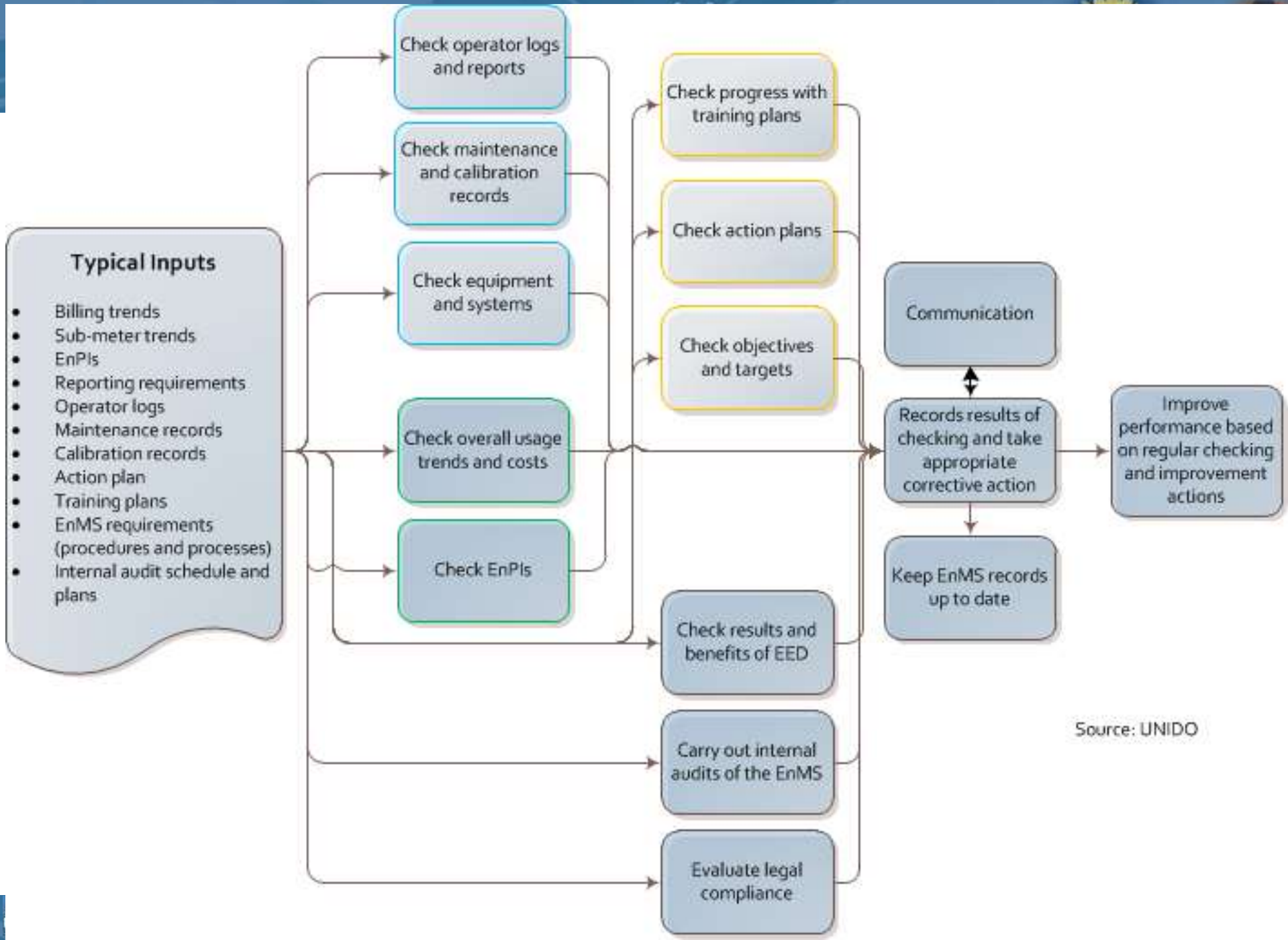
What is checking?

- Keeping an eye on things

Checking



- Check operations
  - Check operation and maintenance records
  - Check equipment
- Check the system
  - Is everyone doing what is required?
- Check plans
  - Is progress being made
- Check performance
  - Check EnPIs
  - Check trends and costs


Typical Inputs
Billing trends
Sub-meter trends
EnPIs
Reporting requirements
Operator logs
Maintenance records
Calibration records
Action plan
Training plans
EnMS requirements (procedures and processes)
Internal audit schedule and plans
Check operator logs and reports
Check maintenance and calibration records
Check equipment and systems
Check overall usage trends and costs
Check EnPIs
Check progress with training plans
Check action plans
Check objectives and targets
Check results and benefits of EED
Carry out internal audits of the EnMS
Evaluate legal compliance
Communication
Records results of checking and take appropriate corrective action
Keep EnMS records up to date
Improve performance based on regular checking and improvement actions
Source: UNIDO

Technical checking

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

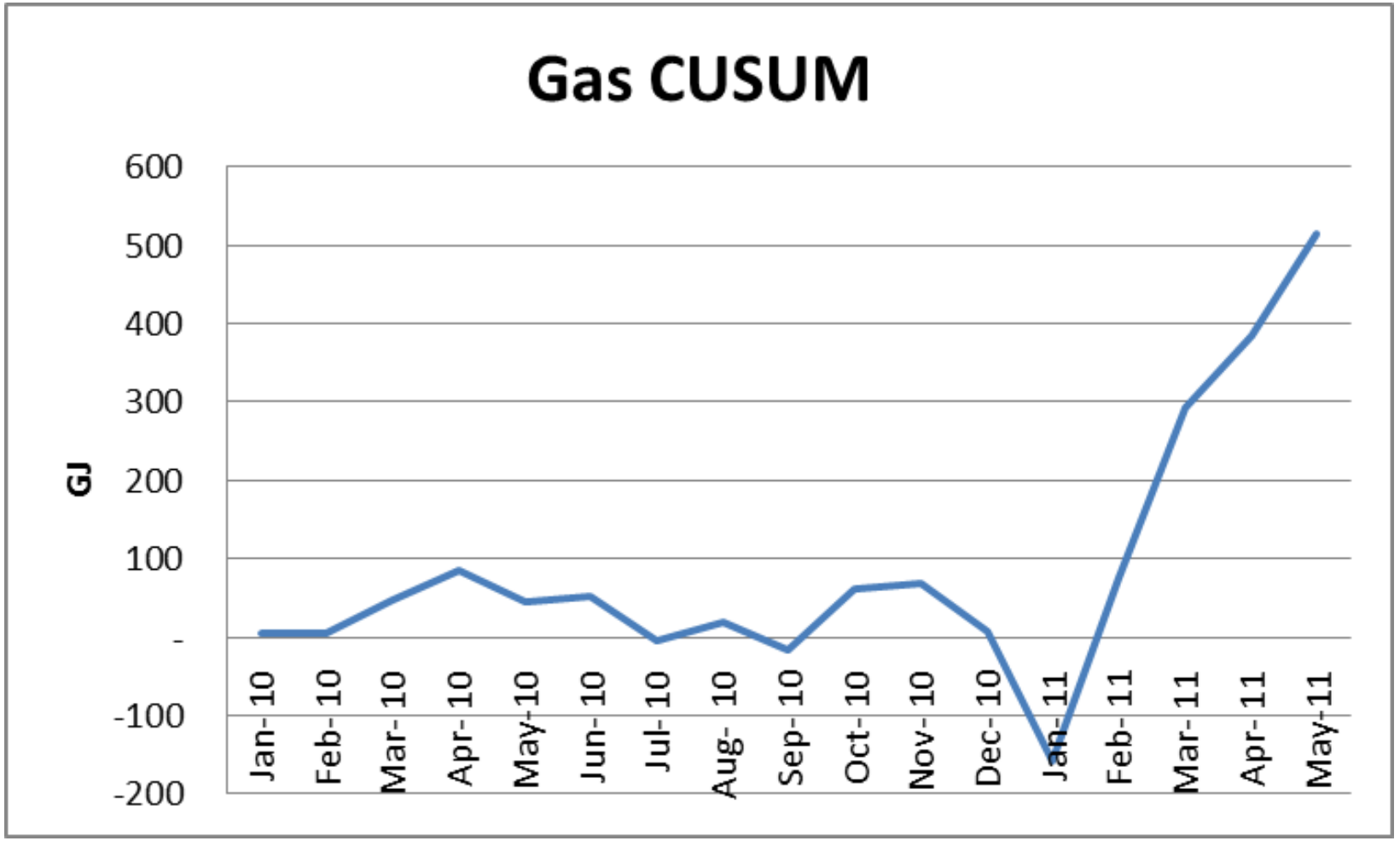
Competence for technical checking

- There are a number of options including:
  - Skilled technician checks
  - Semi-skilled person checks
- Skilled technician
  - Trained and competent to understand what they are seeing
  - Can evaluate problems and decide on solutions
  - In this context skilled means energy knowledge and experience
- Semi Skilled person
  - Trained to complete log sheets and recognize changes, problems and deviations
  - Needs skilled person to evaluate problems and check logs
  - With experience will improve
- Critical Operating and other Parameters

Monitoring and targeting (M&T)

- M&T is a very useful technology
- A lot can be achieved with a spreadsheet
- Many M&T projects fail
  - Initial novelty wears off
  - Poor understanding of what is wanted and delivered
  - Poor management of data and its collection
- See slide on metering plan
- Refer to energy metrics
- Can be an automated monitoring system
  - Monitor EnPIs
  - Monitor other energy parameters

Gas example


Gas CUSUM
GJ
600
500
400
300
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100
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-100
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Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10
Oct-10
Nov-10
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System checking

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

Generating a non-conformity

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

Are these worthy of a report?

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

Non-conformities

	A	B	C	D	E	F	G	H
1	ID	Description	Source	Corrective Action	Resp	Target Completion	Actual Completion	Potential results
2	1	Steam Boiler efficiency 3% lower than expected for 3 weeks	Operational	Recalibrate oxygen trim	MM	25/12/2010	28/12/2010	Fuel waste
3	2	Waste water treatment operators not trained in blower operation	Internal Audit	Complete training	JB	01/03/2011		Inefficient operations
4	3	Chiller no 1 condenser pressure set too high for 1 month	Operational	Reset and train	MM	01/02/2011		Electricity waste
5	4	Boiler insulation removed and not replaced for 6 months	Operational	Replace and reinforce importance				
6	5							
7	6							
8	7							

Significant Deviation

What is it?

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

What do I do?

- Investigate
- Take appropriate action
- Keep a record

What is an internal audit?

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

An internal audit is not……

- A technical energy audit
- An assessment of the viability of an energy saving opportunity
- An assessment of the energy efficiency of a process or system
- An assessment of the performance of individual people
- A battle between the auditor and auditee(s)

Who can carry out an internal audit?

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

What is reviewed

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

Internal audit preparation

- Verify which elements of the EnMS are to be reviewed
- Identify sources of information required in the audit
- Check that people, information and other resources needed are available at the time of the audit
- Review findings of previous audits and deviation reports
- Prepare audit check sheets

The audit

- Starting the audit
  - Meet the relevant people and explain the purpose of the audit
- Conduct the audit
  - Collect and verify objective evidence
  - Establish audit findings
    - Have a closing meeting with the responsible person(s), communicate findings and agree any corrective actions
- Audit report
  - Prepare and distribute the audit report
  - Log any corrective actions agreed
- Audit follow up
  - Review progress on corrective and preventive actions

The auditor

- The role is to find and report on verified facts found during the audit.
- Never:
  - Find fault in individuals
  - Attribute blame
  - Impose predetermined corrective actions
  - Pass judgement or be judgemental
- The auditor should:
  - Be mannerly and courteous
  - Not argue, either agree or disagree
  - Explain issues as they occur
  - Keep your composure and maintain sense of humour
  - Control the time spent on the audit

Internal audit plan

	A	B	C	D	E	F	G
1	**Section**	**SEU**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
2	Record Keeping	**Utilities**	**MM/JB**				
3	EnPIs	**Production unit 1**		**MM/JB**			
4	EnPIs	**Utilities**			**MM/JB**		
5	Communications	**Administration**				**MM/JB**	
6	Objectives and Targets	**Waste Water Treatment**					**MM/JB**
7	Operational Control 4.4.6	**Production unit 2**					
8	Planning	**Refrigaration**					
9	Non-conformances and corrective actions	**HVAC**					

Notes

- Compliance audit
- Process audit
- Audit individual parts of the system in individual SEUs

  Examples
  - Audit planning in the steam system
    - Audit checking in the main production process
  - Audit implementation and operation in the administration building
- All SEUs and all parts of the EnMS should be checked (internally audited) typically annually
- A certification audit is very similar to an internal audit
  - Accredited certification body
  - More formal
  - In accordance with ISO17021 / ISO17024

Performance checking

- We have a baseline energy performance
- We have targets for performance improvement
- We need to know if we are meeting our performance improvement targets
- We have Energy Performance Indicators (EnPIs)
- This can be a complex topic depending on your industry and your energy drivers

- You need to regularly compare actual EnPIs with expected values
- Typically at least one EnPI per SEU

Other checking

- Legal and other requirements compliance
- Results of EED

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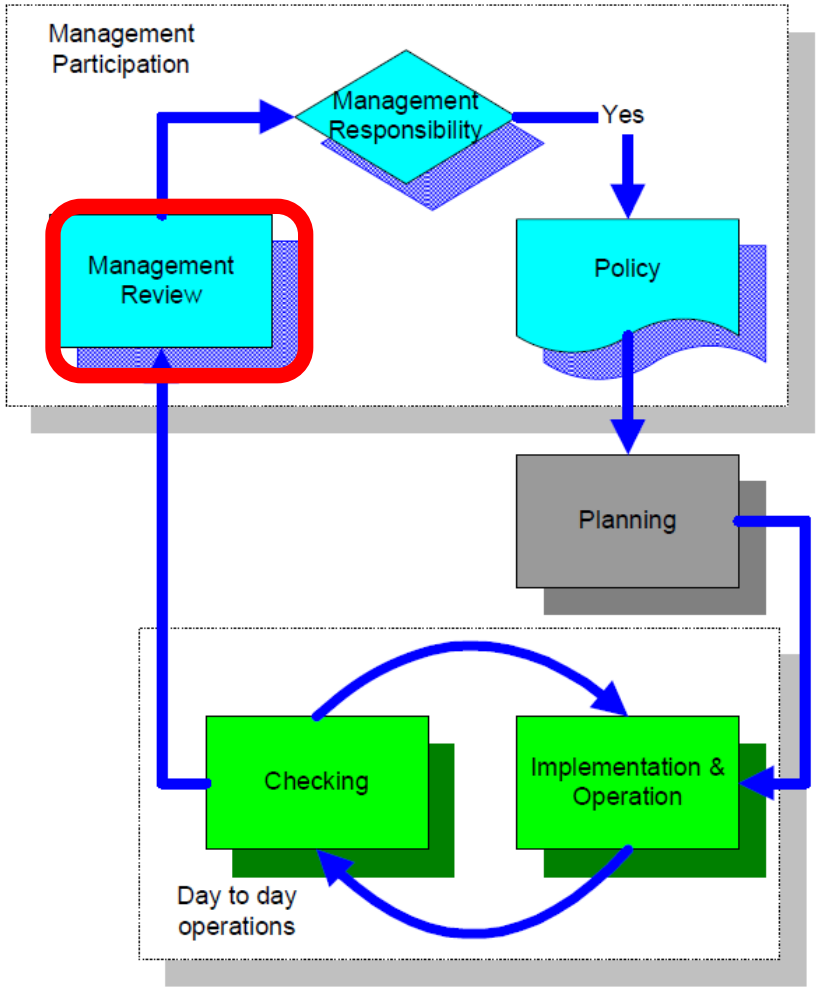
Management Review



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

Purpose

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

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

When does it occur?

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

Who should attend

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

Sample agenda

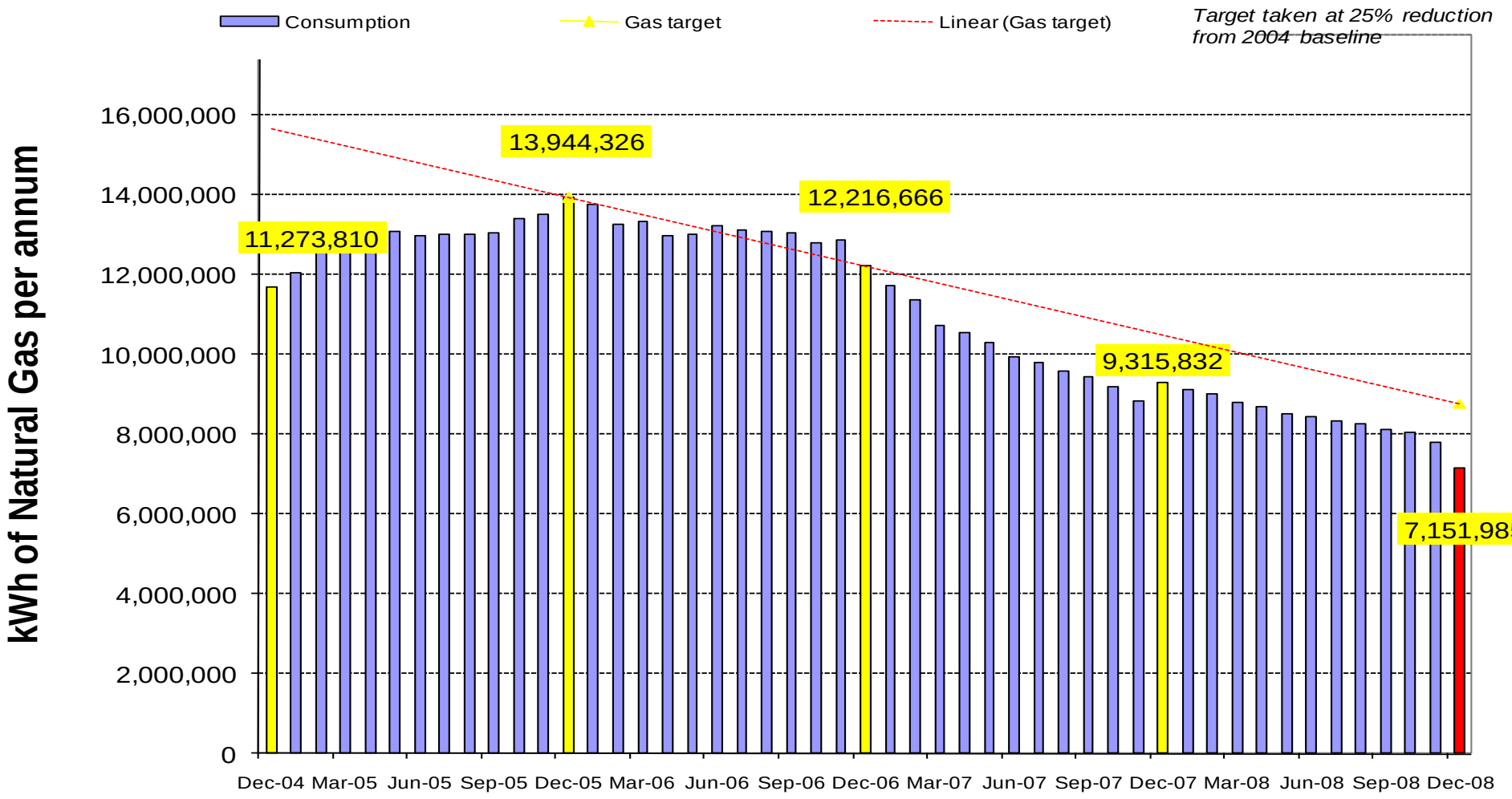
- Review of previous period performance
- Review
  - Main findings of internal and external EnMS audits
  - Compliance with legal and other requirements
  - Changes required due to external influences
  - Status of previous years objectives and targets
- Next Year Plan
  - Are changes required to the policy?
  - Proposed objectives and targets
  - Proposed action plan
  - Projected performance
  - Required resources

Outputs from the review

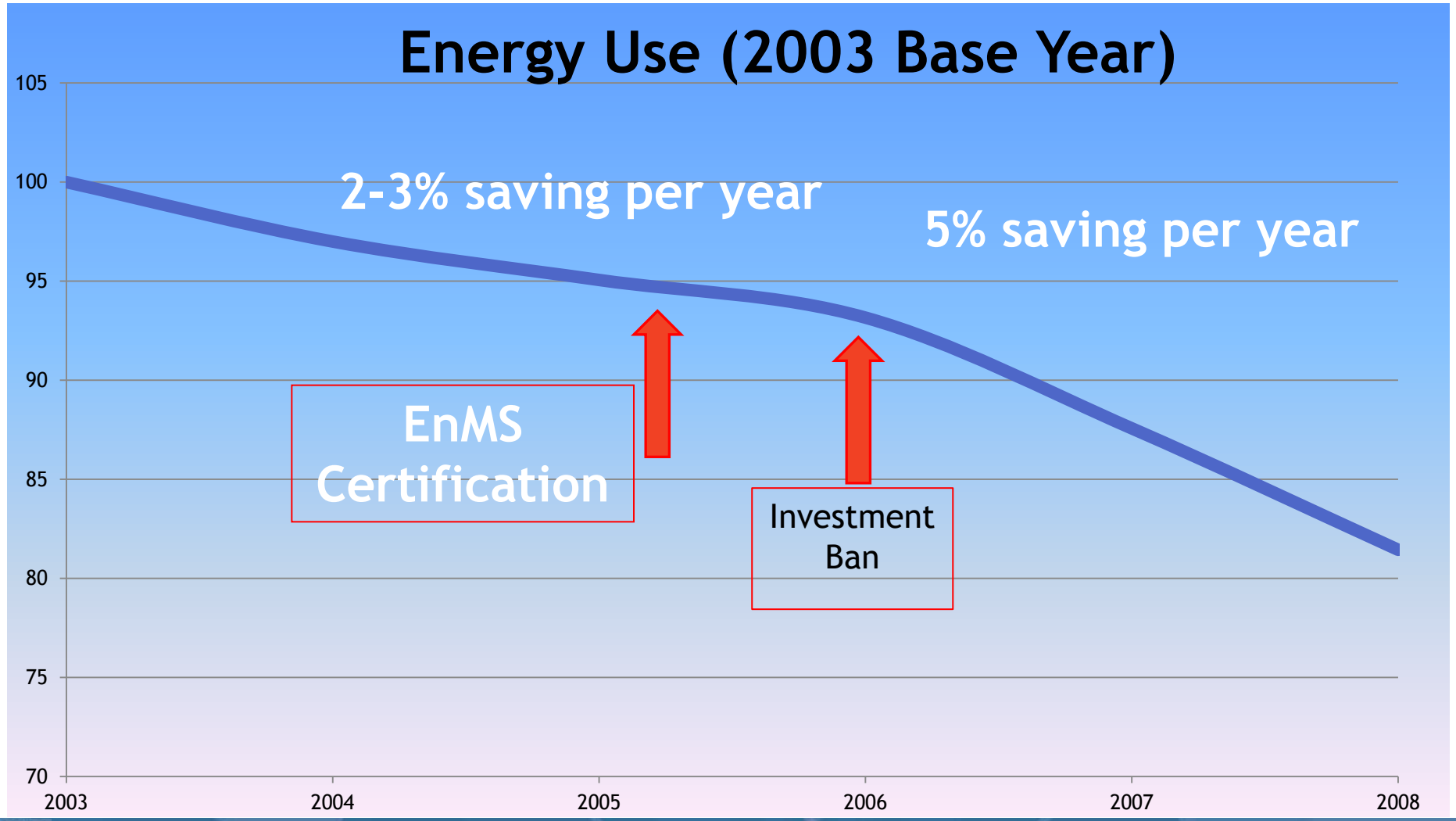
- Minutes of the meeting
  - Decisions made
  - Action items, who, when
  - Attach the presentation to the minutes
- Date of next meeting and its attendees

CERTIFICATION OF ENMS

Case 1 – no certification



Case 2 – no energy saving



Case 3 – good balance

EnMS – No!	• Energy Manager (EM) Opposed • Bad experience with ISO 14001
EnMS – Yes!	• Top management decision • EM reluctant
EM Control	• Add value only • Value = improved energy performance
Result	• Simple system • Part of daily operations • Certification • Improved Performance

Case for certification

Savings	• None added
Voluntary	• Incentivise, e.g. SEAI
Image	• Collector
Cultural	• Many like rules
Fixed Date	• Less likely to drift
Verification	• Independent • Clients, national schemes • Need for international consistency
Focus	• Management and others

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Checking - part 1	0.5		09:30	10:00
Break		0.25	10:00	10:15
Checking - part 2 inc tools	1.25		10:15	11:30
Q&A - checking	0.25		11:30	11:45
Management Review	0.5		11:45	12:15
Lunch		0.75	12:15	13:00
Integration with other MSs	0.25		13:00	13:15
Workshop - planning, operating and checking	1.5		13:15	14:45
Break		0.25	14:45	15:00
Review workshop results	0.75		15:00	15:45
Close out inc feedback form	0.5		15:45	16:15
Next Steps	0.5		16:15	16:45
Day 2 End			16:45	

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Integration of Management Systems

- Many organisations will like the concept of an integrated management system

- ISO 9000 Quality MS
- ISO 14001 Environmental MS
- OHAUS 18001 Safety MS
- etc

Option 1 – Keep them separate

- Advantages
  - Potentially simpler
  - Independence for energy people
  - Potentially less bureaucratic

Option 2 – Partial integration

- Advantages
- Use existing systems
  - Document control
  - Training management
  - Non-conformities
  - Policy

Option 3 – Full integration

- Advantages
  - Reduced certification costs (if applicable)
  - Very neat
  - More people involved in systems

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Structure of the workshop

- We will break into 4 groups
- Each group will appoint a recorder and a presenter
- Each group will discuss the issues and prepare a 10 minute presentation
- Each group should include at least one person from an operating plant. The exercise should be carried out based on the needs and data of that organisation
- The course leaders will move about to observe and answer any queries which will arise.
- The results will be presented in the next session.

The task……

- Group 1
  - Prepare a presentation on how your organisation should go about developing an EnMS, main components, barriers to success, target areas for particular focus
- Group 2
  - Complete as much as possible of the planning stage of the EnMS. Where data is not available either make valid assumptions or describe exactly what data you need to fill in the gaps
- Group 3
  - As above for day to day operations
- Group 4
  - As above for checking and management review

Input material for each group

- Group 1 (EnMS development)
  - Existing knowledge of the selected plant, learning's from this course, own experience
- Group 2 (planning)
  - Planning input data; bills, org structure, drivers, identify SEUs, list potential EPOs
- Group 3 (imp & op)
  - Focus on SEU list
- Group 4 (checking)
  - Highlight 4 aspects of checking

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Agree to go ahead and get committment

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

Carry out the planning steps

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

Carry out the implementation and operation part

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

Discuss the above vs your normal EM practice

Thank you

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

Source: Microsoft