



Industrial Energy Efficiency

Verification and management on on-going performance, Lecture 4 A

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Improving university curricula in the areas of

a) energy efficiency in the sectors of energy, industry and buildings, and

b) renewable energy sources (AHEFs AM-54, AM-55, AM-56)

BUILDING PARTNERSHIPS FOR ENERGY SECURITY

Lecture Learning Objectives

- To introduce the concept of management of energy on a continuous basis
- To introduce the concept of practical Energy Performance indicators as opposed to default metering
- To introduce the concept of independent auditing for improvement internally on a regular basis



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Managing Performance



- To manage performance in an industrial setting, energy needs to be part of the job, and not treated as a separate requirement
- Verification of ongoing performance is a requirement for all areas of significant energy use to allow us to be sure that energy on a whole is being managed correctly
- Responsibility for the energy use of an area of significant energy use should be allocated to the person responsible for all other aspects of that area.

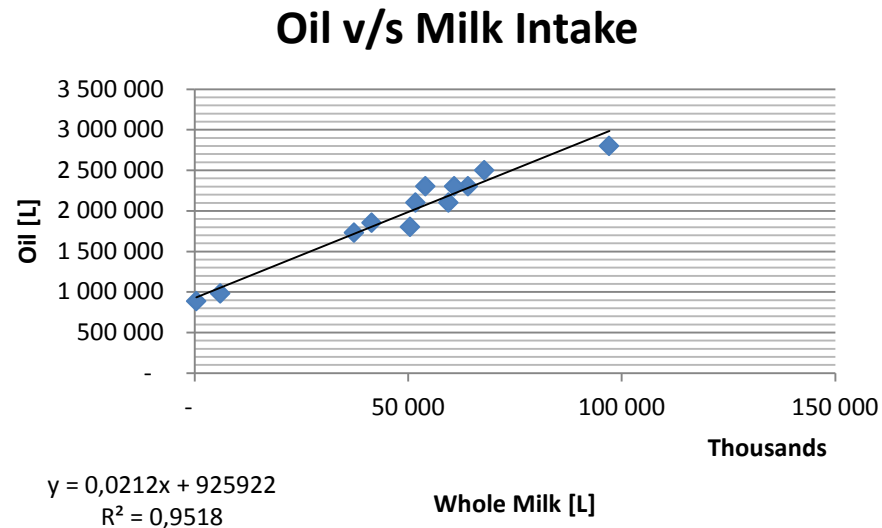
Steam and Steam Boilers



- The natural approach is to look at boiler efficiency.
- This is worth considering to review on a regular basis in conjunction with maintenance
- Comparison should always be made with the actual efficiency seen and the performance stated by the manufacturer in its specification sheets.
- Any shortfalls should be understood

Steam & Steam Boilers 2

- The second performance indicator for steam and steam boiler system for this should be based on previous performance



- Oil use per Month = **0.021*(Litres Whole Milk) + 12406 MWh**
- Deviations up or down of in excess of about 4% should be investigated

Identify anything to prevent this happening



- Appropriate metering needs to be installed to allow reasonable recording of the oil consumption as opposed to checking invoices
- New meter required.
- We need a mechanism to ensure that the milk volumes delivered per month are communicated to the utility person in a timely fashion. Preferable automatically instead of having to look for it continually

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Ventilation



- This depends here if the ventilation system in place has active control to increase and decrease rates of flow with ventilation requirements or not.
- For fixed flow rate applications it would be sufficient to monitor air flow, or simply motor current on a periodic basis.
- What is the most likely thing to cause waste?

Ventilation (cont.)



- Consider setting up a virtual meter on the building management system to monitor air flow/ motor current, and to flag when increased beyond an expected value
- Maintenance to investigate and report on any deviations seen

Refrigeration



- The load on refrigeration will vary winter to summer
- The refrigeration load will vary with production variations
- It has been identified as 22% of electrical load and so cannot be ignored because it appears difficult
- We can monitor refrigeration plant performance efficiency COP and COSP in conjunction with maintenance periodically
- For a valid EnPI we should consider installing an electrical meter with data logger and establish over time the relationship between refrigeration electricity use and the production and weather variables

Things to do



- We need to install an electrical meter and derive the model of refrigeration use.
- The refrigeration use should be compared with data from a similar site (if available)
- EU BREF guide is a good data source.
- Likely causes of shortfalls in performance will be condenser or evaporator fouling. (think back to when we looked at the variables affecting significant energy use in Lecture 1)

Pasteurisation



- Here this is straightforward
- We know that the closer that the approach temperature is the better the efficiency
- Set a desired temperature for the milk heated leaving the regeneration section of the heat exchanger
- If the milk leaving the regeneration section of the plant is less than 67.5 degrees (67.92% is 94%- target efficiency), then initiate cleaning cycle request (build up of film or dirt on inside of exchanger (water or milk side) likely cause

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Drier



- As we earlier noted that the improvements in drier optimisation will lead to increased throughput of the driers.
- Simplest, and most effective energy performance indicator here will be tons of product dried per hour.
- Installation of individual steam meters and analysis over time may allow further optimisations to be identified by analysis of trends seen.

Appropriate EnPI's



- We have looked at appropriate Energy Performance indicators
- These only work if there are continuously monitored and responded to when they go out of expected range
 - Comparison of actual v/s expected use

If you don't know what to expect then it is a useless administrative exercise

80% of Energy Monitoring and Targeting systems installed in businesses save NO energy

Tips to setting EnPI's

Where the activity is cyclical, then the monitoring interval should correspond to a multiple of the interval length

- Eg., If a production cycle in a business takes 3 days, and the use of energy depends on the position of production in the cycle, then monitoring energy consumption weekly will lead to inconsistent values

Tips to setting EnPI's (cont.)

When monitoring energy on a system that has two different production modes then sometimes it is better to have separate performance indicators

- Eg., Production Line A in Use only
- Production Line B in use only and Production line A & B in use
- Sometimes easier to have two different EnPI's

What about multi-variable regression?

- Multi-variable regression can assist and should be used where it makes sense – not just because it gives a formula that describes the relationship
- Statistical analysis on the data can tell you when adding in variables to a relationship assists or not
- “t” value < 2 then the variable adds little to the relationship and can possibly detract
- Be careful that variables are truly independent and not semi dependent

Excel Options – Add-ins

- several pre-installed add-ins available in Excel
 - "Analysis ToolPak"
 - "Analysis ToolPak VBA,"
 - "Conditional Sum Wizard."
- [Excel Add-Ins Tutorial | eHow.com](http://www.ehow.com/way_5304492_excel-addins-tutorial.html#ixzz1yKq1QEOo)
http://www.ehow.com/way_5304492_excel-addins-tutorial.html#ixzz1yKq1QEOo

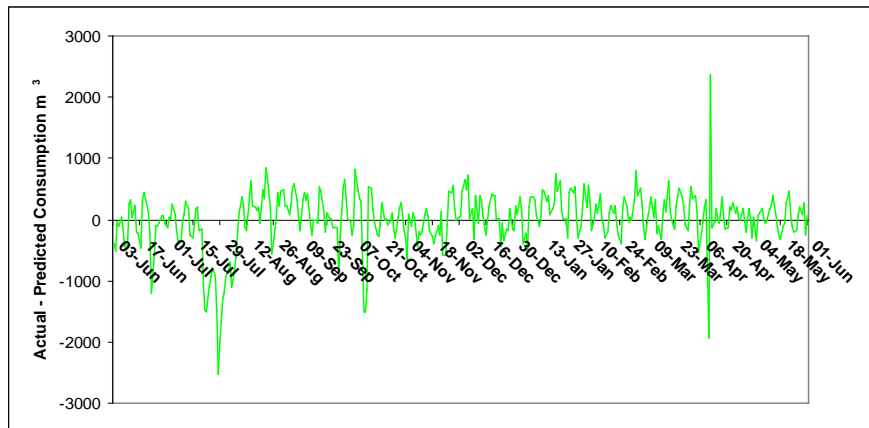
Standard Deviation and CUSUM

- When monitoring performance to identify improvement we are concerned about trends rather than discrete events
- This allows us to identify continued trends in one direction or the other
- NOTE: Do NOT attempt to use standard deviation and CUSUM to monitor energy UNTIL your energy “model” or performance indicator is sufficiently strong to explain what is happening

Standard Deviation



$$s = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}}$$



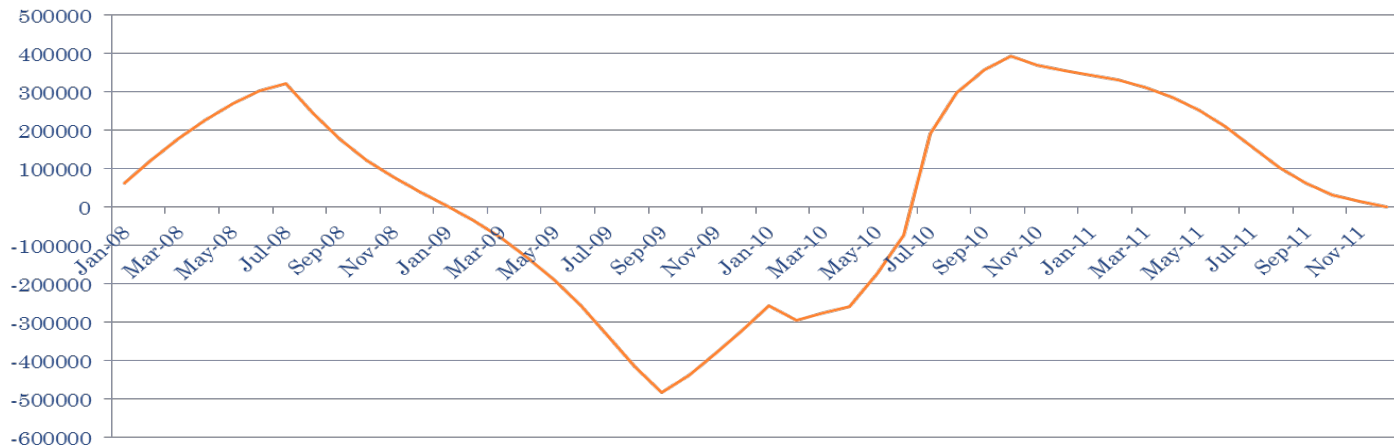
Excel Function
= Stdev($X_1:X_n$)



When the Standard Deviation is consistent then look at CUSUM

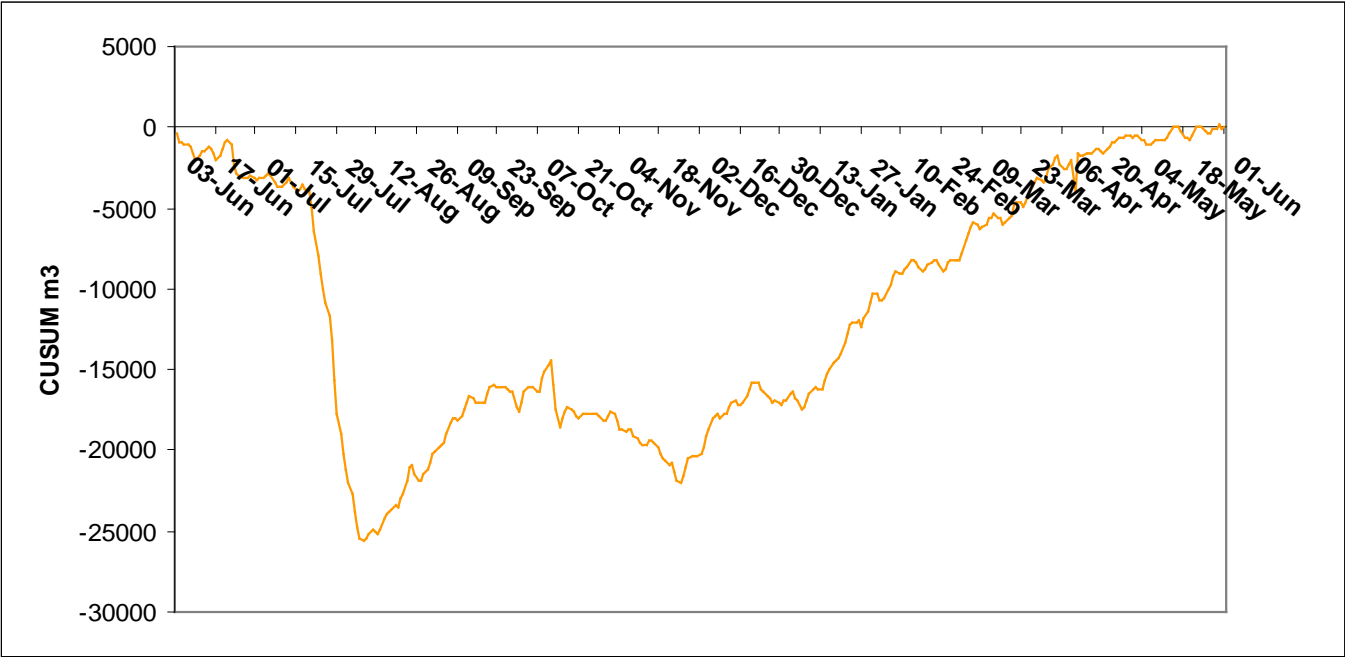
- When we see that the deviation becomes consistent, or that the standard deviation becomes small, then we know that the model reasonable accurately reflects what is happening
- Now CUSUM can be a good tool to use.

CUSUM Graph



- ▶ A CUSUM graph show the cumulative sum of the difference between the actual energy used and the expected energy use based on the regression analysis formula

CUSUM



As stated in Lecture 1



- No silver Bullets
- Energy managed as part of ongoing operations
- Best done in a structured manner
- One such structure is using the international Energy Management Standard ISO 50001
- This is now being used by those “best in class organisations”

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What is an Energy Management System



Set of interrelated or interacting elements to establish energy policy and energy objectives, and processes and procedures to achieve those objectives

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What is an EnMS NOT

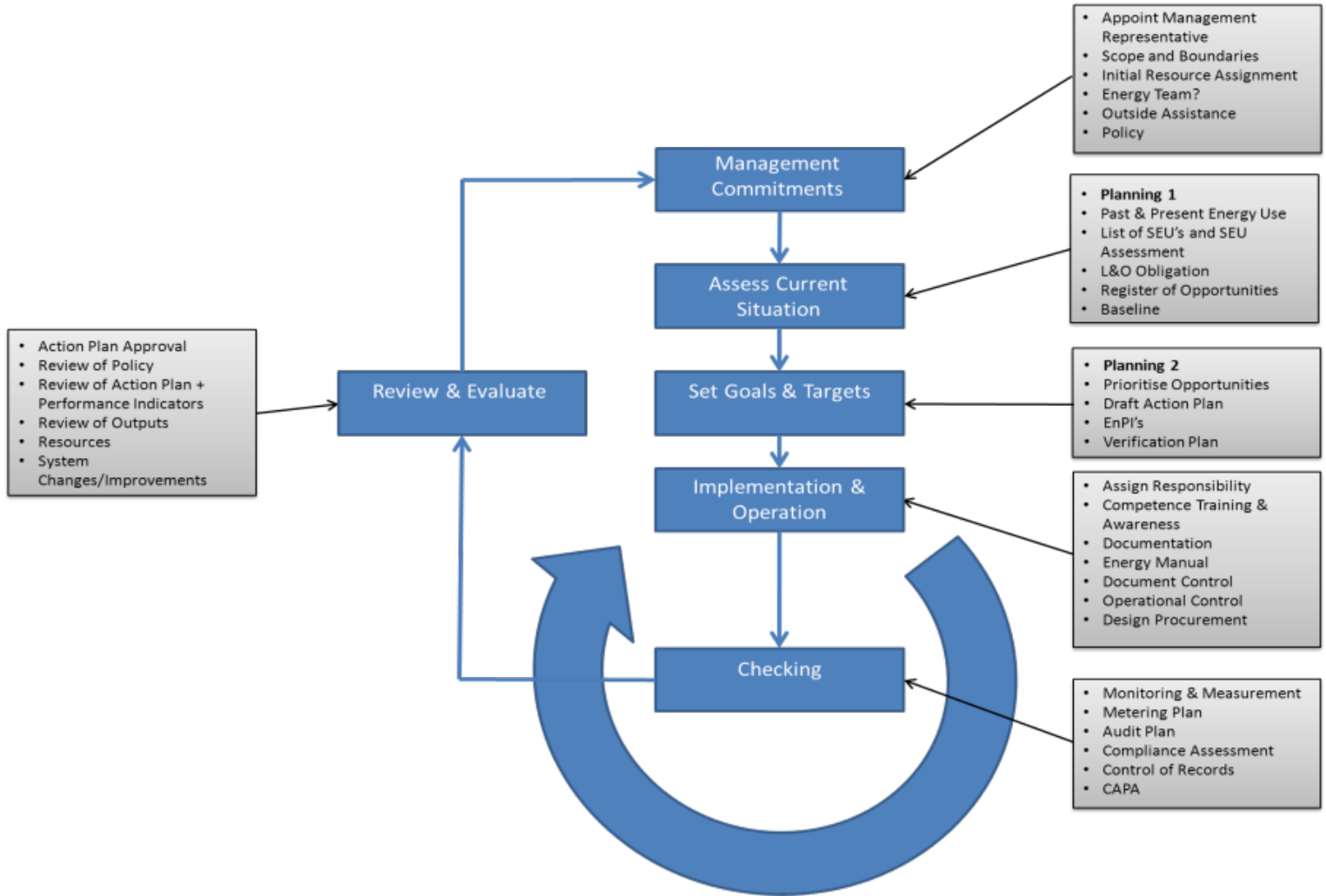


- A piece of software
- A piece of hardware
- A document
- A set of documents
- The energy management system is your system of doing things that manage energy within the organisation.
- When you do this in a way that meets all the requirements laid down you have an ISO 50001 compliant energy management system

What does it **NEED**?



- Management Commitment is a ***MUST***
- This does not mean **just** signing a policy
- Management must give **support**, resources and information
- Management must understand that **improvement** means **change**



How to get there



- Decide our scope and boundaries
- Make someone responsible for the energy management system, and the management of energy
- Assess our overall energy use and its relationship with main driving factors
- Identify our areas of significant energy use
- Assess our areas of significant energy use for opportunities for improvement and our legal and other obligations related to energy

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Continued



- Prioritise our opportunities for improvement
- Decide on our targets for energy performance improvements
- Develop and communicate our policy
- Develop an action plan for what we are going to do for the coming period to deliver these improvements
- Communicate what we are doing about energy internally
- Identify how we will decide if our system is working or otherwise
- Develop and use performance indicators to assess our performance
- Implement our plan

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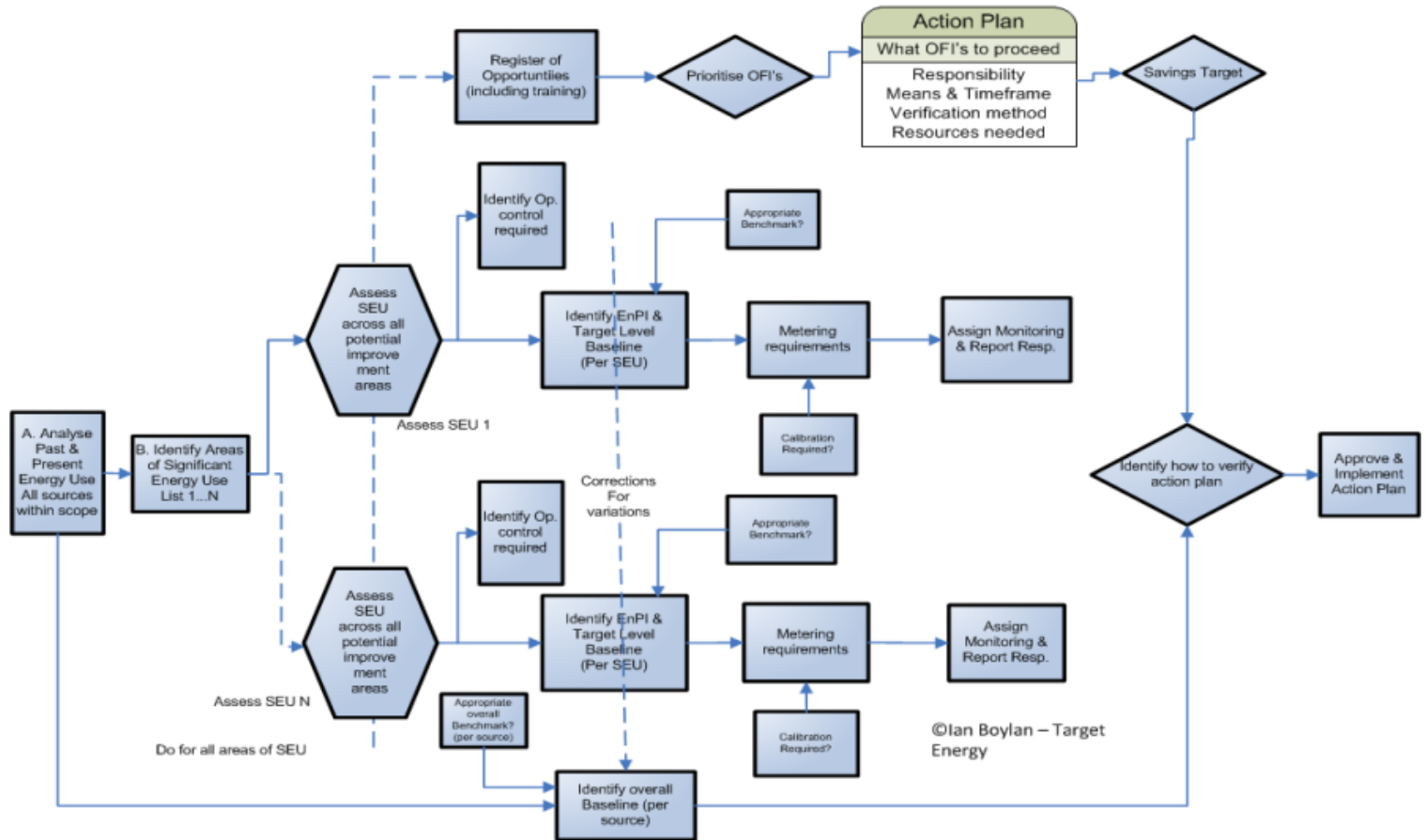


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- Document the structures we have for energy management within our organisation
- Put in place an audit plan to check that we have decided we were going to do is what is being done
- Conduct our own internal audits
- Assess how we are performing and identify potential opportunities to improve this performance
- Top management to assess the adequacy of effectiveness of the energy management system

A Structured process to setting up your ISO 50001 System



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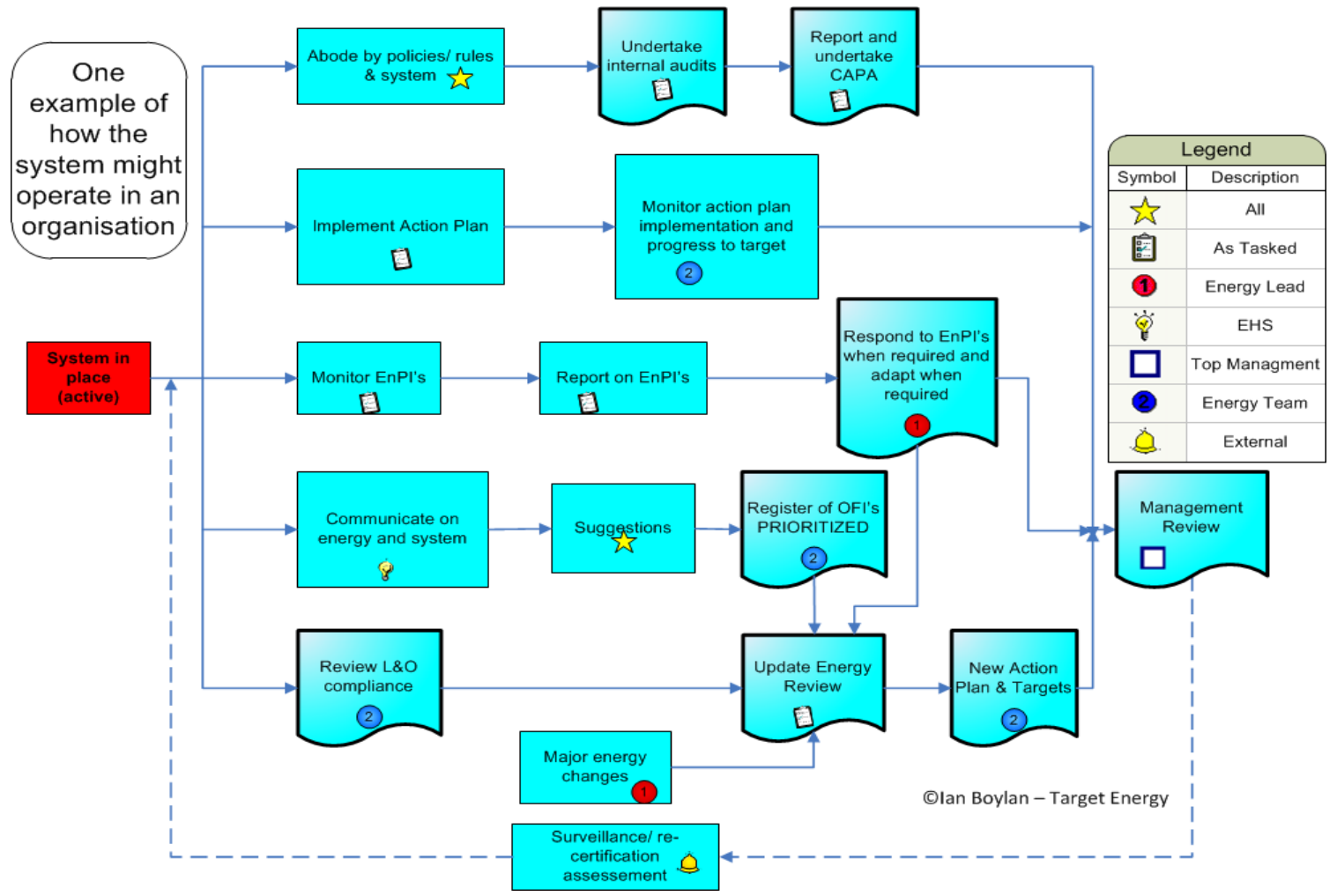
Putting energy performance as an integral part of the organisation

- Energy should be seen as “one” of the key performance indicators of the organisation as a whole (along with quality, environment, health and safety, production, profit etc)
- Best implemented as part of a cross-sectional team (not one Energy Champion)
- This is an ongoing (not a once off) activity



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Result



- Energy efficiency becomes a key component of the organisations approach to what it does
- Energy management is integrated into the organisation and not a bolt on addition
- Peoples understanding of their energy impacts, and the organisations training approach improves
- Improved understanding and interaction between management, manufacturing & support elements of the organisation
- Improved energy performance along with these other benefits

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Effective Internal Audits – the Key to success

- Effective internal audits typically identify energy opportunities but also sometimes conflicts that we did not think of when developing our approach to implementation.
- Improvement means change, do not be at all reluctant to modify your approach where justified
- A good internal audit does not necessarily mean lost of identified non-conformances, but if you never spot any, is it that they don't exist, or that you are not checking for them.



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Auditor Competence and Independence



- Who is Competent
- What is competence – a combination of
 - Education,
 - Training
 - Skills
 - Experience
- Competence is not simply established by a person doing a course, or passing an external exam.

Evidence



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- Competence is an evidence driven activity
- If I review an organisation energy consumption and identify lots of energy opportunities that exist and they have not been identified as part of the energy review process, I have reason to believe that either the planning and review undertaken was not given adequate focus and or the individuals doing it were not competent to undertake the task assigned.
- Conversely if it largely meets the requirements and most of the opportunities have been identified I have no reason to suspect any issues in relation to competence.

The Key to energy success



- Energy being “part” of everyone’s job
- Key people identified, know their responsibilities and given the tools and resources to do the job
- Top management support to back up what needs to be done
- Energy “consistently” on the agenda, not sometimes that raises its head from time to time with increased bills
- Commitment with a team approach

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Questions/ comments?

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