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Tips for ESOS Energy Audits

The Energy Savings Opportunity Scheme (ESOS) energy audit is an assessment of an organisation's energy consumption and energy efficiency that aims to identify tailored and cost-effective measures which could be implemented to save energy. The energy audit forms a key part of an organisation's ESOS compliance and in this feature, two ESOS Lead Assessors offer their practical approaches to undertaking ESOS energy audits.

Astley Fenwick,
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PREPARING FOR AN ENERGY AUDIT

It is important to make contact with the on-site representative as soon as possible and at least 2 weeks before the planned audit visit. I usually arrange a Zoom or Teams meeting and discuss the information required prior to my visit. The list below could provide the basis for a discussion, although it is for guidance only.

<u>Request for information prior to the audit visit</u>

1. 12-months of electricity and gas consumption, including qualifying date, indicating the total use for each month. This should be in the form of copies of monthly utility bills.

2. Half-hourly data for electricity for the same time period as above.

3. Details of transport fuel and company travel for the same time period as above.

4. Details of all air conditioning and chillers (F-Gas Register would suffice).

5. A3 layout plans of all floors of each building for annotation. Fire plan layouts would suffice if nothing else is available.

6. Operating hours of each department.

7. Any restricted areas and where special PPE is required.

8. Organise an employee to accompany me during the audit and ensure access to technical information regarding building services (lighting/power/heating/hot water etc.), along with all major energy consuming equipment.

9. Copies of previous ESOS reports, if produced for previous compliance period(s).

<u>Data collection: poor and good data</u>

Poor data is that which is generally incomplete with regards to 12-months energy consumption requirement and is also not readily available. This informs me that the participant is not striving to regularly monitor their energy consumption and set possible reduction targets. This is an occurrence which is not often met since most ESOS complaint companies are usually efficient with regards to energy record documentation. However, if data was missing, say for one month, then an average consumption figure may be estimated and used within the report. The acceptance of this method depends on whether the utility is seasonally affected, i.e., heating or cooling of buildings. In which case, the data may not be linear. Any assumptions or estimates must be specified within the ESOS Report.

Good data is that which can be clearly understood and with as many recorded values as possible. With electrical energy, half-hourly data is usually available which is excellent for highlighting energy being consumed outside of normal working periods. Unless

the operation is 24/7, but then the Christmas holiday period can show when the facility is shut down and energy consumption should be as low as possible.

CONDUCTING AN ENERGY AUDIT

My first action with any on-site audit is to hold a pre-start meeting with the participant and my escort. This allows for:

- *A discussion about the business operations in general as well as any installed equipment in particular.*
- *A confirmation of the organisation's approach to energy management for which I use the Carbon Trust's Energy Management Matrix.*
- *An identification of any safety requirements with regards to the Health and Safety Executive (HSE), and areas which may be prohibited for access.*

Once on-site, I would initially visit the 'hidden' areas such as plant rooms, boiler rooms, air compressors, large chiller plant and switch rooms. I would glean as much information from the equipment with regards to power ratings, operation times, maintenance procedures, and look at the general condition of the plant and surrounding areas. This can provide an insight of the participant's attitude to the control of efficiency measures and operating procedures. As an example, with compressed air systems I would review time control, operating pressure indicators and discuss if the control pressure is not too high. I would check to see if a variable speed drive is installed to control pressure and if the equipment is air cooled, to ascertain if the waste heat can be used to heat up adjacent areas. Similarly with boilers, I would review time control, temperature control settings, if heat recovery is in operation and check for missing manifold and pipework lagging.

As with the 'hidden equipment', all other building services should be reviewed during a walkabout with the escort, visiting every area of the site. During this exercise, I would gather data for the Significant Energy Consumption (SEC). This

should include everything that is used during the operation of the building. Three key questions are used for this.

1) What does it do?
2) What power rating is it?
3) How is it controlled (i.e., automatic time control, manual control)?

This may appear to be a long drawn out operation but it is important so as:

a) not to miss any equipment that is important, and
b) to ascertain as much information as possible to form a close representation of the facility's SEC.

EVIDENCE COLLECTED DURING THE AUDIT

The type and number of all significant energy consuming equipment. The list below is provided to indicate a 'typical' facility's equipment, although it is for guidance only.

- *All major plants to possibly include production;*
- *Motors (speed, control, etc.);*
- *Heating systems primary source (boilers/unit heaters);*
- *Compressed air systems;*
- *Lighting (internal/external);*
- *Air conditioning equipment;*
- *Domestic Hot Water (DHW) systems;*
- *Catering equipment and small power system (kitchen units, computers, AV, etc.) ;*
- *Electric space heating;*
- *Renewable energy systems.*

Further notes include:

- *Location and type of equipment annotated on A3 floor plans for reference;*
- *Photographs to draw attention to anomalies and also as an aide memoir to assist with the report;*
- *General condition of significant equipment, i.e., missing lagging, leaking pipes, temperature set points, time control settings (if used), control methods (if applicable), lighting control (manual/occupancy/daylight);*
- *Confirmation of verbal information received from the escort regarding the three key questions mentioned previously.*

<u>Tools for collecting evidence</u>

It is important to understand that all audits should be carried out in a non-evasive manner and that no controls should be operated except by the escort. My main tools

Become an ESOS Lead Assessor

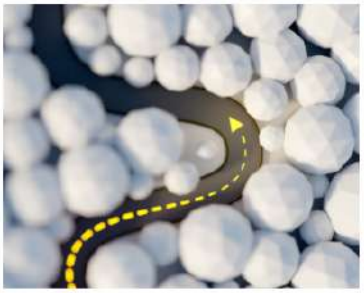
Play a fundamental role in the Energy Savings Opportunity Scheme (ESOS) cycle by ensuring that organisations complete their ESOS compliance in line with the regulatory requirements and by its deadline.

Why

Becoming an ESOS Lead Assessor is a great way to demonstrate your professional ability and step up to the next level in your career. If you achieve this professional status, you can state your sector focus and specialism, allowing you to provide even more value and expertise to the organisation you are working for. ESOS Lead Assessor could be an employee of an organisation which qualifies for ESOS ('in-house') or a third party consultant.

How

Applicants who aim to become approved as ESOS Lead Assessors are expected to demonstrate a good quality and relevant professional energy assessment and energy auditing experience relevant to the PAS 51215 competencies and register with one of the ESOS Lead Assessor Registers.



EMA ESOS Lead Assessor Approval Process

Applicants who decide to achieve their ESOS Lead Assessor approval and registration with the EMA will follow these steps:

1. **Completion of an Application Pack**
2. **Attendance of the Become an ESOS Lead Assessor course**
3. **Completion of a written assessment**
4. **Completion of a Peer Review and Technical Interview**

What Next

Email us or arrange a call to discuss the requirements of the EMA application and approval process.

E: jana.skodlova@theema.org.uk - W: www.theema.org.uk - T: 0203 916 5516

are my eyes and an inquisitive mind. The advantage being that this is my first time looking at the systems with a fresh mind and no paradigms in my mind. When asked why and what, the escort will often say: "We've always done it like that and it works." I also use a digital camera and where required a thermographic camera which can be used to indicate poor insulation. A 13A plug in voltage display is used to check to ensure voltage levels are not too high and ascertain if voltage control might be applicable.

WRITING A REPORT

Listed below is a 'typical' list of the information that I would include within an ESOS Report. This follows the requirements of the Environment Agency for ESOS Phase 3. The report should be easy to read and understand, not too technical (calculations can be included within the Evidence Pack), but provide guidance to the 'decision makers' who could act on the recommendations.

An important subject to mention is that the recommendations and energy saving opportunities are for guidance only and indicate 'ball park' estimations. Before financial assets are committed, firm proposals and costs should be obtained.

- *Executive summary (including risks and uncertainties);*
- *Introduction (site details);*
- *Site energy profiles (benchmarking);*
- *Energy management practices – existing/proposed;*
- *Energy reduction opportunities (Net Zero);*
- *What next?;*
- *Appendices – assumptions/ evidence pack;*
- *Conclusions;*
- *ESOS energy assessment report sing off form.*

TIPS FOR ANALYSING ENERGY CONSUMPTION

Total Energy Consumption (TEC) is comparatively easy to provide based upon the utility and transport information provided by the participant. This is the first exercise to be undertaken before writing the report because it will highlight any areas which could fall under the de minimis statement of 5% of the TEC, in which case it may not be included.

Significant Energy Consumption (SEC) compilation is a fairly lengthy process but ensures that the information and data gathered during the audit visit represents a reasonable profile compared to the TEC. The exercise does, however, require estimation of operating hours and loading factors of the equipment, both of which can be noted and discussed with the escort during the audit. I find it extremely useful to use Excel software for this exercise.

For the electricity profile, I produce a graph indicating a monthly profile for the qualification period. Depending on the facility, this could indicate seasonal changes and holiday periods. Using the half-hourly data, I will produce two graphs which indicate the average yearly profile for the 24-hour period and also an annual profile for the daily totals. The former indicates the average profile of the electrical load and if consumption is significant outside 'normal' hours. The latter graph can provide a profile of normal demand against out of hours. This greatly helps to understand what amount of energy is being consumed during the time when the building is not in normal use and hence wasting energy.

With regards to gas consumption, the information received from the participant is usually in the form of monthly use for the qualification period. Again, a graph is produced to indicate the monthly use. If the energy is used for heating only, it would be expected to fall to zero during the summer months. For heating and hot water services, a use for hot water should be noted in the summer. The use of degree day information will also be useful to ascertain the correct profile of the heating. However, if gas is used for production purposes then the profile will not be seasonally indicated and the information gathered and used in the SEC may be used for comparative purposes.

TIPS ON SELECTING ENERGY SAVINGS OPPORTUNITIES

In most ESOS audits, I usually discover that the participant's approach to energy management is not significantly embedded within the company's operations. My first opportunity is to recommend that they produce an Energy Policy to steer the company in the direction of a formal approach. Included within this is the introduction of an energy monitoring system which will provide the basis for better control and understanding of their consumption. It is widely accepted that a minimum of 5% saving can be achieved by energy monitoring and setting reduction targets.

My next stage of looking for recommended savings is to look at those areas which require no or little capital expenditure. This could include reviewing set point control for heating and cooling, compressed air pressure control (the industry standard being

6bar), installing plug in timers for water heaters, vending machines, etc., training of staff to switch off equipment when not in use or occupancy sensors for lighting. These are examples only and there could be other suggestions for similar applications.

My latter stage in recommendations would be to assess the efficiency of the existing processes and equipment with a view to the costs to replace with more efficient type. A simple case would be the replacement of fluorescent lighting with LED type. Furthermore, the operation systems, for example of an air handling plant (AHU) and water pumps would be reviewed to ascertain if the motor's speed could be controlled using variable speed drives. For instance, if the air flow from an AHU is controlled via a damper in the unit, then installing a VSD could reduce the speed and thus save energy. All of the above suggestions will require some capital expenditure and I would review the attractiveness of proposals by using a payback criteria and recommending the lowest payback period at the 'top' of the list.

TIPS ON ESTIMATING COSTS AND BENEFITS OF ENERGY SAVINGS OPPORTUNITIES

The saving of energy is obviously the reduction of kWhs (energy used and time taken) associated with the equipment being reviewed. The most assured method of reduction is to reduce the time the equipment is in operation by improved control and possible training. The next option is to reduce the power required for the equipment by either replacing or introducing technology to become more efficient. I have already mentioned VSDs but this could also include heat recovery systems on ovens, boilers, etc. Heat recovery from air cooled compressors could be another option. When estimating budget costs for recommendations it is advantageous to be able to have information such as SPONS which provide up to date information.

Payback periods, which in the majority of cases, the participant prefers when reviewing saving opportunities. Life cycle costs are very useful when reviewing the replacement of equipment with a more efficient type. For example, replacing a motor with a high efficiency one could reduce the energy consumption by some 5% saving £X per year. The cost of the motor being say £Y. Under normal payback scenarios this may not be acceptable. However, over the expected life time of the motor, the savings could be significantly higher due to greater efficiency, say £Z. Therefore, as long as £Z is greater that £Y it is seen as an energy saving. In most cases, the replacement of motors with a high efficiency type would only take place when the original motor has failed and repair work is greater than replacement costs.

TIPS ON ENCOURAGING STAKEHOLDERS TO IMPLEMENT ENERGY SAVINGS OPPORTUNITIES

Before I leave the premises, I always hold a 'wash up' meeting with the participant and escort to review my findings and discuss what proposals I may be including within the report. Generally, during the audit, there will be occasions where improvements can be identified and therefore discussed. During the meeting, it may be possible to gauge the opinion of the participant regarding their attitude towards the suggestions.

Following the presentation of the report to the client, I will propose a Zoom or Teams meeting with the participant to review the report and the attractiveness of the recommendations. I try and assure the participant that I will be available to discuss the details of the recommendations within the future should they wish. Depending upon the level of involvement, I will state that no charge for this will take place.

Author's profile:

Astley is an ESOS Lead Assessor with almost 48 years' experience within the building services sector, and 35 years' experience with industrial power and process control systems. His specialities include power distribution, lighting, motor drives, HVAC controls, compressed air systems, building services design and maintenance as well as running stakeholders' engagement campaigns in his previous role as energy manager at GSK.

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PREPARING FOR AN ENERGY AUDIT

After preliminary contact with the customer, a start-up meeting is held with a company representative to identify their Significant Energy Consumption (SEC) and an appropriate sample of their

sites for audit. Once relevant sites are identified as a representative sample of the client's activities and building stock, dates are agreed for the audits to be carried out on-site.

Data

Probably the most important part of the whole ESOS process is data gathering. We all want the data to be supplied to us in a clean format (date down one column and KWh/ Miles/Liters down the next) or, even better, in half-hourly format from SMART meters with that rich granularity that allows you to delve into baseloads and other analysis. In reality, this is never the case, and the data usually dribbles in piecemeal via scraps of photocopied invoices and various spreadsheets with ambiguous column headings.

Poor data is the data you can't trust because it's not from a primary source. An example can be where you've had to extrapolate monthly figures out of quarterly gas invoices or estimating office electricity consumption using floor area from the landlord's whole building invoice. It's primary data that is best – monthly actual meter reads for electricity and gas (or other fuels) with little or no credit notes or, as previously stated, data from SMART meters. Unfortunately, I encounter good data rarely in the data gathering process and you need to develop methods for manipulating poor data to give you some level of granularity that you can do some work with – remember to note down any and all assumptions you've made during the process though, to allow others to track where you've got your final data from.

CONDUCTING AN ENERGY AUDIT

I undertake all ESOS audits as Type 1 Audits, as identified by ISO 50002. They are carried out with further detail provided where necessary to evidence potential energy savings. I use BS EN 16247-1:2012 as a template for the energy audit delivery process:

- *Preliminary contact;*
- *Start-up meeting;*
- *Collecting data;*
- *Fieldwork and on-site audits;*

- *Analysis;*
- *Report;*
- *Final meeting.*

Every audit will be different, whether they are site based or done remotely (common for fleet audits). I try to have all my data gathered in beforehand to have an understanding of the site's annual energy use/patterns and what fuels they use. One of the most important aspects to planning the audit is to have the correct person available and on-board for the audit. This is not always the top manager, although they can certainly be helpful, but more often than not, the facilities person or maintenance manager is the ideal person as they have an in-depth knowledge of everything that happens on-site.

Try to gain an understanding of the main activities for each site before you visit as this will often dictate what you need to look at during the audit. For example, if it is a manufacturing site, what type of processes do they have and where are they using their energy – is it thermal, motive, pneumatic, hydraulic?

EVIDENCE COLLECTED ON-SITE

My main areas of focus when on-site are usually split into Heating, Hot Water, Production Equipment, Lighting, Air Handling & Air Conditioning, Office Equipment, Catering & Miscellaneous Equipment. For each of these I do an Energy Use Profile where I gather in as much evidence as I can under the headings below that allows me to produce an estimation of the energy split for the site.

- *Quantity (How many of each type);*
- *Equipment Rating (Watts if possible);*
- *Usage (Hours/Day -Days/Week – Weeks/Year).*

There are a multitude of tools that can be used to gather in this evidence, and these can range from cheap to expensive but, in general, I have found that having a pen, notebook and a camera or phone is usually adequate. Taking photos of wider areas, including equipment alongside individual photos of each piece of equipment and its rating label (if available), really helps when going through your audit notes to build up the energy split, especially if there is an extended period of time between the audit and write up.

WRITING A REPORT

The new requirement for ESOS has made it mandatory for all participants to submit an ESOS report. All reports are there for an audience and therefore it is important that they provide the best information and story to the client. Use charts to present data in a concise format and clear tables where a chart is not possible. For both, always discuss the data as there will be insights that can be gained. Reports should have consistent formatting to make it easy for the reader and keep the language simple and precise. I generally structure my reports to follow these headings, though some reports will change depending on the client's request.

- *Summary Action Plan / Audit Based Recommendations;*
- *Lead ESOS Auditor / Company Director Sign-Off;*
- *Auditor and Audit Methodology;*
- *Summary of ESOS Phases I and II;*
- *Total Energy Consumption for ESOS Compliance Period III:*
  - *Total Savings Achieved During Phase III;*
  - *Top 5 Energy Consumers;*
- *Energy Intensity Metrics:*
  - *Fleet;*
  - *Buildings;*
- *Audited Sites Common Savings Opportunities;*
- *Group Total Energy Saving Potential;*
- *Top Low or No Cost Saving Opportunities;*
- *Top Investment Opportunities.*

TIPS FOR ANALYSING ENERGY CONSUMPTION

There are many tools available to analyse energy consumption, but many are costly to buy, and need training and time to master. Try to develop your own, repeatable methods for analysis (i.e., develop spreadsheets that require minimal data input but generate multiple outputs). I regularly use self-developed spreadsheets for the following consumption data:

- *Heating degree day analysis;*
- *Cooling degree day analysis;*
- *Half hourly data analysis;*
- *Extrapolation of quarterly to monthly data based on typical consumption patterns.*

TIPS ON IDENTIFYING ENERGY SAVINGS OPPORTUNITIES

My main tip for choosing opportunities would be to use all your senses when carrying out an audit. Don't just rely on what you can see or what someone tells you to be the case. What can you hear when on-site? Is there traffic noise from outside an office? This might suggest that the windows are not performing well. Is there a hissing noise on the factory floor? The pneumatic circuit may be leaking and the compressor running unnecessarily. Does any area feel too hot or too cold? The heating/cooling system may not be operating or controlled correctly or there may be a lot of personal heaters in use. Can any daylight be seen around loading bay doors or are there any conveyors running without products on them? Also, talk to the employees as you are going around as they are the ones that are there all the time. They will be able to tell you, very quickly, if they have experienced any issues and this is a gold mine (usually).

TIPS ON ESTIMATING COSTS AND BENEFITS OF ENERGY SAVINGS OPPORTUNITIES

I tend to align my use of Life Cycle Cost Analysis (LCCA) and Simple Payback Period (SPP) with the ESOS guidance. I use SPP for short term capital investments (less than 3 years) and LCCA for long term capital investments (more than 3 years).

The spreadsheets I have developed automatically calculate SPP for all my recommendations and I use this to order these in my Summary Action Plan / Audit Based Recommendations tables. For the long term investments, my spreadsheets output both Investment Rate of Return (IRR) and Net Present Value (NPV) that allows the client to make informed decisions for larger capital outlays.

Author's profile:

Sean is currently working as Lead Energy Engineer for Environmental Strategies Ltd. He has a diverse background in several fields including Engineering, Construction and Further/Higher Education. Sean holds a BEng in Manufacturing Engineering, an MSc in Energy Conversion and Management, and a PhD in Engineering.